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MASSACHUSETTS  
AGRICULTURAL EXPERIMENT STATION

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Annual Report

For the Fiscal Year Ending November 30, 1939 - June 30, 1940

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

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# ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION — 1939

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## INTRODUCTION

F. J. Sievers, Director

The State of Massachusetts is a pioneer in the inauguration of legislation for the regulation of sales of commercial fertilizers. This interest first expressed itself in an Act passed in 1869 at the instigation of the State College after, in its services to the agricultural industry, it became evident that great opportunities for misrepresentation and fraud existed in the fertilizer merchandizing methods then in operation. While this Act was intended to prevent the manufacture and sale of adulterated fertilizers, it did not carry the enforcement provision to make it effective. Later, when results from investigations conducted by the Experiment Station provided a sound basis for determining fertilizer values and requirements, additional legislation was urged by the College and in 1888 a law was enacted which, with slight modifications, is still in effect. This law provided the desired control and was recognized as sufficiently sound to give direction to similar legislation now in force in every state in the Union.

In some states, the authority for administering and enforcing this and other regulatory acts is delegated to the state department of agriculture while in others, of which Massachusetts is an illustration, this is the responsibility of the agricultural experiment station. Irrespective of which method of administration may at present be considered more desirable or effective, it is evident that the long history of investigations conducted by the experiment stations in closely related activities has contributed heavily to the intelligent interpretation of the law, a matter very essential in a just enforcement program. Massachusetts has been especially fortunate in having had agricultural regulatory services entrusted to individuals who were not only keenly concerned with serving the interests of the public but who were also sufficiently fortunate in personality to attract the cooperation necessary to develop a scientifically sound and agriculturally practical leadership.

This discussion in the 1939 Annual Report is timely because the year covered terminates almost coincidentally with the compulsory retirement date of Professor Henri D. Haskins. Professor Haskins retired on December 27, 1939, after almost fifty years of continuous service in the Experiment Station, during which he has been identified with this particular control service since its inception and in direct charge of its enforcement provisions for the major portion of the entire period of its operations.

It is not intended to evaluate the services of Professor Haskins or to evidence the high esteem in which he is held by his associates, a recognition well deserved and worthy of much more elaboration than is possible here. His exemplary administration does, however, set a standard for idealism in public service which not only warrants the enthusiastic support it has received from both farmers and fertilizer dealers but also bears direct evidence that the legal regulation of activities so closely related to agricultural practice may, for soundest interpretation and enforcement, be wisely delegated to the Agricultural Experiment Station.



## DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

**Adjustments in Dairy Farm Organization and Practices in Massachusetts.** (C. R. Creek and Emil Rauchenstein — in cooperation with the Bureau of Agricultural Economics of the United States Department of Agriculture.) Work on this project during the past year consisted of the preparation of a manuscript on the study which is now being considered by cooperating workers in the Bureau of Agricultural Economics.

In addition to the previous calculations of net returns on wholesale and retail dairy farms, normal returns were computed for the wholesale group on the basis of normal or average expenses and income for the ten-year period 1926-35. The average labor income per farm was increased for each of the five areas by which the farm records had been classified. In Berkshire County normal receipts were higher and expenses less, which increased net returns by \$218. In the Connecticut Valley counties the increase was less — \$122 per farm. The increase was greatest in the southeastern area where normal labor income was \$298 greater per farm and was lowest for the farms in the northeastern area at \$64 per farm. For individual farms the increase in returns under normal price conditions was low for specialized dairy farms and relatively high for farms with a poultry flock; but for those farms with cash crops of potatoes or apples, normal returns were lower than the actual farm income in 1937.

Combinations of farm enterprises with the dairy business were analyzed and those farms with almost one-fourth of the total receipts from the poultry flock had the lowest returns per farm. A small number of dairy and fruit farms showed the highest incomes; while dairy and cash crop (potatoes, tobacco, or onions) combinations were more profitable than the average of all farms. On those farms with income from poultry, crops, and dairy the net returns were also high with an average labor income of \$956 per farm.

A comparison of all the specialized dairy farms with a similar number of the most diversified farms showed a loss of \$18 per farm in labor income for the former and a gain of \$802 for those farms with other enterprises than the dairy. The diversified farms were larger in total size of business, more labor was required, and this labor was more efficient than on the strictly dairy farms.

Budget analyses were made of successful dairy farms for each of the five areas to show items and amounts of receipts, expenses, and capital investment as well as the various factors of size, production, and efficiency. The same analysis was made for each of four types of enterprise combinations with the dairy business. Pasture and hay improvement practices, methods of feeding the dairy herd, crop fertilization practices, and other methods of management were discussed for each farm.

**Enterprise Relationships and Farm Organization on Selected Farms in Massachusetts.** (C. R. Creek and Carl Bokina.) A study was made of physical inputs and costs of producing set onions on 25 farms in the town of Hatfield for the 1938 crop year. The total costs of growing and harvesting an acre of onions averaged \$267 on these farms with a total of 126 acres. Less than four acres per farm were grown on 17 farms and only two farms had 15 or more acres. Man labor averaged 509 hours per acre with a range from 371 to 667 hours. Fertilizer was applied at the rate of 2860 pounds per acre, and 29.6 bushels of onion sets were used. Man labor, which included the value of the operator's time and of family labor, accounted for 47.7 percent of all costs, while sets and fertilizer were each 18 percent.

Labor costs were analyzed by various operations and the greatest amount of work was in cultivating and weeding at an average of 187 hours per acre or 37 percent of all man-labor costs. Clipping the onions required 106 hours, and setting 97 hours per acre. Of the total man labor, 56 percent was expended before the time of harvest.

This study was published by the department in mimeographed form, entitled "Inputs and Costs of Producing Set Onions in Hatfield, Massachusetts."

**Labor Saving Methods and Techniques on Vegetable Farms.** (C. R. Creek and Richard Elliott.) Data were collected for this study by timing the various operations in the packing of celery on 15 market garden farms in three areas in Massachusetts. Duplicate sets of data were obtained on stripping, washing, wrapping, and packing celery on each farm.

The size of the crew working in the packing shed ranged from two to twelve persons. The number of boxes of celery (one dozen bunches) which were packed per farm ranged from 15 to 117. On two farms 13 boxes were packed per hour for each person working and on two smaller farms only 5 boxes were packed per man per hour. The other farms ranged in efficiency from 7.5 to 12 boxes per man per hour.

The number of boxes of celery which were packed depended upon the efficiency of labor, the size and quality of the celery, the arrangement of tubs and benches in the washroom, and the method of handling the celery. The greatest number of boxes was put up by crews of young men who worked rapidly for a longer time and were more dexterous, especially in wrapping. Some bunches required three or four stalks of celery instead of two on farms where dry weather or blight had affected the celery. On those farms where the benches, tubs, and tables were arranged in a row the greatest number of boxes were packed per hour and per man. On farms where extra care was taken to pack celery of high quality more people were working and the output was lower per person.

A preliminary report on this project was published in the *Massachusetts Commercial Vegetable Grower* for November, 1939.

**Competitive Factors Influencing the Supply of Market Milk and Cream in Massachusetts.** (A. A. Brown and J. E. Donley.) Milk marketing continues to command major attention. Studies in the Springfield milk shed are nearing completion. Two reports have been recently published: "Milk Cartage in the Southwick-Agawam Area of the Springfield Milk Shed," Bulletin 363; and "Product-Costs of Milk to Dealers in the Springfield Area, 1935," Bulletin 365.

The determination and appraisal of the location and characteristics of the supply within the milk shed are the current and final phases of the investigation for this market. Significant findings to date are numerous. Three might be specifically mentioned.

First, it has been found that the bulk of the dairy farmers make low average daily deliveries to the market. Analysis of 1183 records of full-time Grade B shippers showed that 21 percent had a daily average of 86 pounds (one 40-quart can) or less; and 60 percent a daily average of 172 pounds (two 40-quart cans) or less. The weighted average for the 710 shippers in the group was 103 pounds, with a total range from 17 to 1550. Using the average farm price of \$2.465 per hundredweight for the milk shed, these shippers would receive a mean gross farm income from milk of \$2.54 per day. The significance of a small volume of business is in no way diminished even though the maximum price applicable, the Class I price of \$3.25, were used. Should the resultant amount of \$3.35 be the major source of income, it would still be insufficient to satisfy dairymen. Any milk-marketing program should recognize this characteristic of production as a major premise.

A second finding of note is the relationship between volume of deliveries and seasonal variation. The relative seasonal variation between November and June was highest for small dairies. As the daily deliveries per dairy became larger, the relative seasonal variation decreased. The relationship between volume of production and seasonal variation is especially important to a program aiming at stability in a market supplied by 710 producers whose average shipments were 103 pounds per day.

The third noteworthy development was in the study of average farm prices by areas. The milkshed naturally divides itself into 14 areas within which dealers might reasonably compete for supplies or producers compete for markets. On an actual price basis, the average for each area tended to show some logical relationship to location. Three of the areas enjoying relatively high average prices were adjacent to the market; the fourth area of this group and the area with the highest average price were farthest from market. On a common fat content of 3.7, however, the area having the highest average price was adjacent to the market. With this one exception, the areas in which the higher average prices prevailed were at a distance from the market, whereas the areas with the lower average prices tended to be near it. In 8 of the 14 areas, however, the average price was within a range of one-fourth cent per quart. The relatively uniform price in these middle areas suggests a proportional distribution of the same dealers or dealers with similar operations among those areas.

The tendency for higher prices to prevail in the areas more distant from the market is probably due to the absence of competition from flat-plan dealers. The bulk of the flat-plan dealers pick up their supplies close to the market. Since they pay the Class I price for all milk but can handle only a small portion of the supply available, there is probably much unrest among the remaining producers with a strong inclination to shift dealers. Rather than bother with these shifting producers, the larger dealers move into areas too distant for the small flat-plan dealer to haul from profitably. The result of such practice is to throw the bulk of the producers in the nearby areas not using the flat-plan outlet over to use-plan dealers with low Class I utilization. The effect of such procedure would be and probably has been to create an area of constant threat to market stability. This, too, is in contrast to the prevailing notion that the potential sources of cheap milk are "up-country." In the light of these conclusions, a reappraisal of the market organization is in order.

## DEPARTMENT OF AGRONOMY

Walter S. Eisenmenger in Charge

### Tobacco Projects. (Walter S. Eisenmenger and Karol J. Kucinski.)

*Brown Root-Rot of Tobacco.* The crop preceding tobacco frequently exerts a decided influence on the yield and quality of tobacco. It seems probable that the so-called brown root-rot of tobacco may be the result of residual effects associated with the plants grown on the field the previous year. Plants with high lignin, grown on the field previously, give rise to a general soil flora different from the decomposing flora when the lignin is not there in such abundance. Although the lignin is probably not a cause of the trouble, its presence invites a foreign micro-population, thus changing the soil environment for the tobacco roots.

The plan for determining the influence of the preceding crop on tobacco was continued as in previous years, using the same crops, twenty-three in all, including cereal and forage crops, vegetables, flowers, and even weeds.

In general, the various crops ranked about as in other years in their effect on



yield and quality of tobacco. However, 1939 was regarded as an unusually good tobacco year in this locality, and the differences in yield and quality of tobacco following the various crops were not so great as in 1938, which was considered a poor tobacco year.

*Tobacco Grown on Old Sod.* An attempt has been made to overcome the unfavorable effects on tobacco yield and quality usually witnessed when old sod is plowed under preceding a crop of tobacco.

An old timothy sod area was divided into four plots. Plot 1 was given an application of 200 pounds of nitrogen in midsummer of the year before tobacco was grown, and plowed immediately; Plot 2 received no nitrogen, but was plowed at the same time as Plot 1; Plot 3 was given the same nitrogen treatment as Plot 1, but was not plowed until the following spring; and Plot 4 received no nitrogen, but was plowed at the same time as Plot 3.

Plot 1 showed the highest yield and crop index, indicating that the addition of nitrogen to sod plowed the previous summer had caused the greatest decomposition of the ligneous materials in the sod. On the other hand, applying nitrogen the previous summer and allowing the grass to grow produced an accumulation of vegetation which only added to the supply of tissue and retarded the growth of the tobacco. There was probably more nitrogen in the vegetation and soil of this plot (3) than of Plot 4, but it was of little avail in the presence of too much tissue. Lignin is one of the last components to decompose, while ammonification and nitrification are contingent upon the first stages of decomposition.

**The Use of Nitrogen as an Aid in Decomposing Old Sod.** (Karol J. Kucinski and Walter S. Eisenmenger.) Calcium cyanamid at the rates of 100 and 50 pounds of nitrogen per acre was added to an old sod before it was plowed under in the fall of 1938. Another similar sod area, receiving the same fertilizer treatment, was plowed under in the spring of 1939. Although this year's growing season was exceptionally dry, thus hindering the decomposition and nitrification of the old sod, it was found that yields of potatoes, corn, and cabbage were in line with those obtained in previous years. Determination of nitrate nitrogen throughout the growing season for the past three years showed that the rate of decomposition of the old sod was faster where nitrogen was plowed under.

Although the differences in yields and chemical analyses between the respective treatments were not as great as in previous years owing to the abnormally dry growing season, yet the addition of nitrogen to old sods before they are plowed under seems to aid in their decomposition and thus lessens their usually harmful effect.

**The Relative Rate of Nitrification of Nitrogen Materials on Certain Tobacco Soils.** (Walter S. Eisenmenger and Julien Richard.) The purpose of this investigation was to ascertain the fate of various forms of nitrogen from different sources and to establish the length of time each form could be depended upon to furnish a supply of nitrogen to the growing tobacco plant. The materials used were urea, sulfate of ammonia, dried blood, and cottonseed meal. Addition of phosphorus increased the rate of nitrate formation. Organic matter supply was important in increasing nitrate formation. The maximum rate of nitrate formation was reached in approximately thirty-five days, and nitrification apparently stopped in fifty days. In general rate of nitrification, the several materials are ranked as follows (in decreasing order): (1) urea, (2) sulfate of ammonia, (3) dried blood, and (4) cottonseed meal.

**The Absorption by Food Plants of Chemical Elements Important in Human Nutrition.** (Walter S. Eisenmenger and Karol J. Kucinski.) Lettuce, cabbage, and celery were grown on soil to which the cations sodium, potassium, magnesium,

and calcium were added at the rate of 500 parts per million per individual plot. The anions chlorine, sulfate, and phosphate were used on additional plots at the rate of 200 parts per million. The roots and tops of the plants were analyzed to determine the effect of these soil applications.

The results were somewhat inconsistent with those obtained in other seasons, particularly the intake of sulfur by cabbage, which showed a decrease instead of the expected increase. Whether this decrease was due to the season or to some undetermined cause is not yet apparent.

**The Intake by Plants of Elements Applied to the Soil in Pairs Compared to the Intake of the Same Elements Applied Singly.** (Walter S. Eisenmenger and Karol J. Kucinski.) Experience has shown that the application of cations to soil tends to increase their quantity in the plant. This is especially true of magnesium and potassium. The experiment here described was designed to determine whether, when two elements are added to the soil together, the plant will absorb less than it does when each is added singly. The materials used supplied calcium, potassium, and sodium at the rate of 250 parts per million of soil, and lithium at the rate of 100 parts per million. Lithium is exceedingly toxic; therefore it was added several months before seeding. Although the experiment is still in a preliminary stage, a lack of consistency in results is already apparent.

When lime and a potassium compound were applied together, the amount of potassium in the plant was less and the amount of calcium greater in all cases than when the respective elements were applied singly.

When lime and a sodium compound were applied together, there was less sodium in celery and in cabbage (tops) and more sodium in cabbage roots and in lettuce than when the sodium compound was applied alone; there was more calcium in celery and in lettuce and less in cabbage (whole plant) than when lime was applied alone.

When compounds of sodium and potassium were applied together, there was more potassium in celery and less in cabbage than when the potassium compound was applied alone; there was more sodium in cabbage (tops) and less in cabbage roots and in celery than when the sodium compound was applied alone.

The figures for lithium were too few to be of significance.

**The Relative Intake of Certain Elements by Calciphyle Plants and Calciphobe Plants Grown on Soils at Varying pH.** (Walter S. Eisenmenger and William H. Bender.) The question of the relative nutritional value of plants grown under different environmental conditions has led to a study of the intake of mineral elements by the plant, as influenced by the calcium ion and by the hydroxyl ion when both are added to the soil in the form of hydrated lime.

The intake of calcium, magnesium, nitrogen, phosphorus, potassium, and iron was observed on limed and unlimed soil with a pH of 7.3 and 4.4, respectively. The calciphyle plants were barley, sweet clover, and Kentucky bluegrass; the calciphobe plants, oats, peanuts, and redtop; and the intermediate plants, wheat, cowpeas, timothy, and tomatoes.

When lime was applied to the soil, all plants showed an increase in calcium; all plants of the intermediate class and two-thirds of the calciphobe and calciphyle plants increased in magnesium; all intermediate and calciphobe and two-thirds of the calciphyle plants increased in nitrogen. One-half of the intermediate, all of the calciphobe, and two-thirds of the calciphyle plants decreased in phosphorus as a result of liming. No relationship could be determined between intake of potassium and liming. Liming increased the iron content of 80 percent of all plants grown, from which it would seem that the assimilation of iron is not based on its solubility in the soil, for iron is more soluble in acid soils.

Since the application of lime to the soil affected the intake of other elements

besides calcium, it would seem that the hydroxyl ion also has an influence on absorption by the plant.

**Magnesium Requirements of Plants.** (Walter S. Eisenmenger and Karol J. Kucinski.) A plot of land known to be deficient in magnesium was divided into four sections and treated as follows: no treatment, magnesium alone, magnesium plus lime, and lime alone. Eleven species of plants were planted across the sections and observations made as to the sensitivity of these plants to magnesium deficiency and the relative intake of calcium and magnesium for the different treatments.

It was found that when only magnesium was added, all plants increased in magnesium, and seven of the eleven decreased in calcium. When calcium and magnesium were added, one of the eleven plants decreased in magnesium and two in calcium. When calcium alone was added, five decreased in magnesium and three in calcium.

In general, magnesium seems to be much more easily introduced into the plant than calcium when additional amounts are added to a soil. The addition of magnesium plus calcium, on the other hand, may diminish the intake of both elements by the plant.

It was observed this year that calcium applications hastened the maturity of certain cucurbits, as canteloupes and watermelon, by about two weeks; and that those receiving lime were higher in sugar content at maturity than those not receiving lime.

The photograph on page 52 shows the marked response of celery to liming. Cabbage, on the other hand, did equally well on the limed and unlimed portions of the plot.

**Investigation with Various Winter Cover Crops for Onion Fields.** (Karol J. Kucinski and Walter S. Eisenmenger.) Onion growers in the Connecticut Valley do not as a rule use a winter cover crop on their onion fields. A winter cover crop of rye, which is generally used on tobacco fields in the fall, if seeded on an onion field would necessitate spring plowing. It is the practice of onion growers to plow their fields in the late fall in order to have the fields ready for onion planting in the early spring as soon as the ground is free from frost. This practice of fall plowing of onion fields is responsible for the sheet erosion and especially for the excessive dust storms which are witnessed during late fall, winter, and early spring.

It is the object of this investigation to find a winter cover crop which, if seeded in the late fall after the onion fields have been plowed, will produce a desirable cover and yet winterkill so as not to interfere with the early planting of onions.

Last year, buckwheat, spinach, barley, oats, spring wheat, and spring rye were seeded on October 19, on a plowed onion field. Results showed that this date was much too late for production of a proper cover which would prevent wind and sheet erosion. This year, the same cover crops were seeded two weeks earlier. Observations made during the middle of December show that buckwheat and spinach did not produce sufficient growth for an adequate cover, while barley, oats, spring wheat, and spring rye gave promise of a fairly good winter cover.

In the future, it may be desirable to make the seedings somewhat earlier, although with the increasing use of tractor power for plowing, the onion grower has had a tendency in the past to let his fall plowing go until a short time before the ground freezes.

**Onion Breeding.** (Hrant M. Yegian.) The Connecticut Valley onion growers follow the practice of planting seed sets for the production of market onions as early in the spring as it is possible to prepare a proper seed bed. If the sets could



be planted in the fall, the crop could get an earlier start. During the past two seasons preliminary selection of onion plants was made for the purpose of obtaining new types that will possess the characters of high yield and winter resistance, and at the same time will be of the quality desired by the market. Some very promising types have been obtained. Seed sets from these selected types, if planted in the early part of September, will make considerable growth during fall, resume growth early in the spring, and mature good-sized bulbs at the same time as the commercial Ebenezer onions. The characters for "bolting" and winter injury due to freezing and heaving of soil, however, must be bred out and practical problems of fertilization must be solved before the fall planting of sets can be adopted by the commercial growers.

**The Effect of Arsenious Oxide ( $\text{As}_2\text{O}_3$ ), Arsenic Oxide ( $\text{As}_2\text{O}_5$ ), and Antimony Oxide ( $\text{Sb}_2\text{O}_3$ ) on Soil and Plant Growth.** (Hrant M. Yegian and Walter S. Eisenmenger.) The question of whether arsenic is cumulative in the soil and may eventually become harmful to plant growth is important in areas where orchards have been sprayed over long periods or where much arsenic has been applied to lawns for parasites. Antimony was included in the study, not because of its intensive use in agriculture but simply to learn whether an element with chemical properties similar to arsenic acts in the same manner.

Greenhouse experimental evidence on the effects of arsenious, arsenic, and antimony oxides on Merrimac fine sandy loam and subsequent crop growth warrants the following statements: antimony oxide applied to a series of pots did not affect either plant growth or yields of barley and buckwheat, and the soil was not injured even temporarily by applications up to 2000 p. p. m. The pH of the soil at all concentrations was the same, and the nitrification in soil was not depressed.

Three successive pot tests were run for each of the arsenic treatments. The pH of the soil dropped from 6.1 to 5.6 with the heavier application (2000 p.p.m.) of arsenious and arsenic oxides. Arsenious oxide (2000 p.p.m.) and arsenic oxide (600 p.p.m.) did not appear to retard nitrification of cottonseed meal in soil. In the first crop test arsenic oxide, which is very soluble in water, showed a higher toxicity than arsenious oxide, which is relatively insoluble in water. The difference in toxicity of these two oxides was not so pronounced in the second run, and there was no difference in the third run. Concentration of soluble arsenic in the soil, therefore, seems to be the primary cause of arsenic toxicity. The injurious effect of arsenic is primarily on the root system of plants. Plant species, however, vary in susceptibility to arsenic toxicity; furthermore, in open-pollinated varieties there is a variation in the susceptibility of individual plants. Continuous cropping is not so effective in reducing arsenic toxicity as is the increase of organic matter of the soil. In soil, sorption of soluble arsenic takes place in the presence of organic matter. Accordingly, in addition to other soil factors, arsenic toxicity can be related to the organic matter in the soil, being high in soil deficient in organic matter and low in soil well supplied with organic matter.

**Relationship of Natural Vegetation to Physico-Chemical Properties of Soils of Massachusetts.** (Walter S. Eisenmenger and Walter S. Colvin.) Natural vegetation is often an index of the land's potentialities. In this study plant type was correlated with soil type, water-holding capacity of soil, and pH of soil. A total of 425 sites (uncultivated) was investigated and the following observations made.

In correlating plant types with the water-holding capacity of the soil, plants were divided into four groups: those most abundant on land with low water-holding capacity (40 to 50 percent), such as pitch pine, broom sedge, and lespedeza ;

those found most abundantly on soil of medium water-holding capacity (70 to 90 percent), such as sheep laurel and black birch; those found on land with high water-holding capacity (90 to 100 percent), such as sugar maple, beech, and high-bush blueberry; and finally those found with equal frequency irrespective of the water-holding capacity of the soil, such as red maple, lady's slipper, and white pine.

Plants were divided into three classes with respect to tolerance of acidity. The plants found most commonly at low pH (3.5 to 4) were such plants as low blue indigo, lupine, scrub oak, and pitch pine; at medium pH (5 to 6), gray birch, highbush blueberry, sensitive fern, alder, ironwood, meadow sweet, red cedar, and skunk cabbage; at high pH (6 to 7), such plants as ash, canoe birch, buttercup, elm, Kentucky bluegrass, sugar maple, mouse-ear chickweed, common plaintain, English plantain, strawberry, dandelion, and shrubby cinquefoil.

The writers believe that this material could be extended to serve as a guide in evaluating farm land.

**Soil Conservation Research Projects.** (Karol J. Kucinski and Walter S. Eisenmenger.)

*A Survey of Erosion Problems Arising from Changes in Land Use.* It has been shown that there were 1,400,000 bushels of potatoes grown in 1927 in Massachusetts and a yearly average of 1,975,000 bushels for 1928 through 1937. In 1938 the yield was 2,041,000 bushels and the Market Service estimates a yield of 2,324,000 bushels for 1939. Potato growers for the past several years have obtained good prices for their potatoes, thus encouraging them to expand their acreage. In Massachusetts the demand has always greatly exceeded the supply of native-grown potatoes. In some cases large out-of-state growers have come to Massachusetts in order to be close to the retail market.

No previous work has been done to acquaint one with the erosion problem arising from this increase in potato acreage. Growing of potatoes on a large scale is relatively a new venture on some of the farms in Massachusetts, especially in the western foothills and plateau. Numerous acres of old sod have been plowed under on the sloping hillsides for this purpose. As yet only slight sheet erosion is noticed on these fields probably on account of the presence of large amounts of organic matter. Great concern has been felt by some who think that, after a few years of cultivation, the organic matter now present in these new potato fields will decompose and the soil readily erode, since no cover-cropping system is practiced. It is the purpose of this investigation to determine the nature and extent of the area involved. It is of further interest to find out whether these new potato areas are of such character and so located that they would lend themselves to soil erosion if no precautionary measures are being taken by the farmer for its prevention.

*An Investigation of the Source and Nature of Erosional Damage on the Alluvial Soils of Massachusetts.* The object of this study was to ascertain sources and extent of the damages to the alluvial soils resulting from the periodic flood waters of the Connecticut, Merrimack, and other streams of Massachusetts.

In times of serious flood much of the land is covered with silt to depths varying from a few inches to several feet. Some of this deposit is so sandy as to be unfit for cultivation and in some cases constitutes a wind erosion hazard. In other places the material laid down contains very little sand but is high in silt and clay fractions.

A detailed study of damages to agricultural lands was made after the 1936 and 1938 floods along the Connecticut River at the Hadley, Northampton, Hatfield, Deerfield, and Northfield meadows. It was found that the land damages due to the 1936 flood were much more severe than those caused by the 1938



flood. The 1938 flood and hurricane came during and in some instances prior to the harvesting season, thus causing greater economic loss to farmers than the 1936 flood which came when no crops were in the field.

Besides mechanical and chemical tests, pot cultures have shown that fine silt deposited in Deerfield and Northfield meadows was beneficial, while the sandy deposits in Hadley and Hatfield were harmful if more than four inches in depth.

A more general reconnaissance survey of the flood damages to the soils along the Housatonic, Blackstone, Deerfield, and Merrimack was made. Particular notice was paid to the amount, type, and extent of soil damage found along these rivers. Many pictures of the soil damages were taken very soon after the flood, before man had time to obliterate the damages by plowing, scraping, or other methods. These pictures are being assembled for use as illustrative matter in a final report.

*A Study of the Physical and Chemical Properties of Wind-blown Soils.* In the past no one has tried to determine whether there is any relation between the physical-chemical properties of Massachusetts soils and their susceptibility to wind erosion. It has been observed that only certain types of soil in Massachusetts are affected by wind. In general these wind-blown soils are coarser in texture than those soils not subject to blowing. It is of great interest, from both the practical and academic standpoint, to find out just what the true physical-chemical properties are which control the degree of wind erodibility of a soil. It is also of interest to discern which of these various physical-chemical properties of a soil are subject to the control of man and just what changes take place in the soil complex when one or more of these physical-chemical properties are changed by man's management or by natural influences.

Soils from wind-eroded and non-wind-eroded areas are being examined for their physical and chemical properties, such as mineral and organic colloidal fractions, plasticity, hygroscopicity, mechanical analysis, heat of wetting, heat conductivity, capacity of absorption, and such other soil properties as are deemed of value.

Various ions and cations are being added in different rates to the soil to establish their effects on the physical and chemical properties of wind-eroded soil. A wind tunnel is being developed and these soils will be subjected to its influence in order to find the relative effects of the various ion and cation treatments on the wind erodibility of the soils.

*The Relation between the Rate of Wind Erosion and the Principal Factors Affecting it.* Wind erosion, although not the most important, is perhaps the most evident type of soil erosion that is found in the Connecticut River Valley and on Cape Cod.

The dust storms which occur in the Connecticut River Valley prevail mostly on onion and other vegetable fields during the fall and again in the spring when the ground thaws, then dries, and is swept off by the northwesterly winds. Besides the damage to the field and the young vegetable crops, the dust storms are a nuisance to the people living in the Valley. A detailed survey of the Connecticut River Valley has been made in order to determine the extent of land affected. Observations have been made on the soil type and soil characteristics which have a bearing on the problem of wind erosion. It has been found that in certain cases where severe wind erosion is now prevalent, the fertility of the soil is so low that there is some question whether the area should ever have been plowed for intensive cultivation.

From the standpoint of agriculture, the sand dune area of the Cape does not present a serious problem. The dust storm areas are found along the northern and southern shores and the tip of the Cape. Most of these areas are used for

summer resorts and recreation. State agencies have initiated various experimental measures to control the shifting of the sand dunes. It has been found that sod plantation of hog cranberry, beach grass, poverty grass, sand pea, Scotch broom, and blueberry are very effective in stabilizing active sand dunes. Various pine trees, such as *Pinus sylvestris*, *P. Mughus*, *P. austriaca* and *P. rigida*, have also been used very effectively in establishing permanent cover on the dunes.

**Podzols of Massachusetts.** (Arthur B. Beaumont.) Most of the soils of Massachusetts belong under the category of brown podzolic. However, there are two areas in the State where well-developed podzols are found. These areas are at opposite ends of the State and at extremes of elevation—on the Berkshire Plateau at elevations above 2000 feet and on Cape Cod at elevations of 50 to 100 feet, above sea level. There is little difference in mean annual rainfall, which is about 44 inches. Berkshire podzols have been developed from soils of medium base status under a cover of conifers, mainly spruce and northern hardwoods; Cape Cod podzols under a cover of pines, which is now principally pitch pine (*Pinus rigida*). Below is a brief description of profiles of podzols from the two areas:

<i>Berkshire Podzol</i> (Becket fine sandy loam)			<i>Cape Cod Podzol</i> (Hinckley coarse sand)		
		pH			pH
A.	0—3" black humus.....	3.3	0—4" black humus.....		3.70
A.	3—8" purplish gray.....	3.4	4—30" gray.....		4.30
B.	8—12" dark, reddish brown, friable (orterde).....	4.1	30—32" black, hard ppt. humus.....		4.80
B.	12—18" yellowish brown.....	4.4	32—36" coffee brown hardpan..... (ortstein)		4.65
C	18"— yellow till.....	4.5	36"— pale yellow sand and gravel...		4.95

**Sunflowers and Their Possibilities.** (Karol J. Kucinski and Walter S. Eisenmenger.) There is a long-felt need among farmers in the Connecticut Valley for a new crop which can be grown successfully on lands which are being taken out of tobacco or onion production. Although it is known that the country's demand for sunflower seed is greater than the present supply, no information is available concerning the possibilities of sunflowers as an economic crop in Massachusetts. The farmer growing sunflowers would readily find channels for marketing his seed to poultrymen of this region, while the stalk has possibilities as ensilage material for cattle feed.

This experiment was undertaken to determine the rate of seeding, fertilizer requirements, date of seeding, and yields of seed and stalk obtainable when sunflowers are grown under conditions prevalent in Massachusetts.

It is concluded that any land suitable for corn production will also be suited for growing sunflowers. Since the sunflower plant can withstand more cold than corn it can be planted somewhat earlier. Early seeding of sunflowers produced nearly a ton of seed per acre. Seedlings of one seed per hill every 18 inches in 36-inch rows proved to be better than 2 plants per hill in 36-inch check rows. Plants seeded closer than 18 inches apart had a tendency to be thin and weak, causing lodging after storms. When sunflower plants were used for silage it was found that yields as high as 19 tons per acre were obtainable. Cattle that were fed sunflower silage seemed to relish and thrive on it.

The results obtained so far with growing of sunflowers have been very encouraging and further investigation of a more detailed nature should be made to determine the feasibility of growing sunflowers economically in Massachusetts.

**Trials of Thirteen Different Hay Seeding Mixtures.** (Ralph W. Donaldson, W. G. Colby, and Karol J. Kucinski.) Data obtained at the conclusion of four

seasons' harvest of two cuttings per year of various hay seeding mixtures indicate the following: (1) A number of mixtures containing varying proportions of alfalfa showed slight but not significant differences in yield. One containing 50 percent alfalfa (seeded) ranked high in yield — not excelled by straight alfalfa. One mixture containing no alfalfa produced a significantly low yield. (2) Orchard grass in mixtures, while yielding comparatively well, was overmature when cutting was delayed for alfalfa blossom. Timothy seemed more desirable. (3) The average annual yield of hay was 500 pounds less from a 13-pound seeding rate than from either 17 pounds or 21 pounds. (4) A significant response occurred from muriate of potash, 250 pounds topdressed annually on half of each plot. Increased yield of hay due to potash amounted to  $1\frac{1}{2}$  tons, or 50 percent increase, the third season; and 2 tons, or 100 percent increase, the fourth season. The final disappearance of alfalfa on the area receiving no potash, with a good stand remaining on the treated area, apparently accounts for this difference. (See photograph on page 52.)

**Pasture Investigations.** (W. G. Colby.) In Massachusetts there are four principal factors which govern pasture production. They are in the order of their importance as follows: (1) Soil fertility, (2) grazing management technique, (3) species and species strains, and (4) climate.

High quality pasture herbage is probably the most profitable crop which can be produced in Massachusetts, but this is true only when the cultural requirements of this crop are given the same consideration which is now given to other valuable crops grown in the State. Failure to recognize this fact in the past is largely responsible for the present very poor condition of our pastures. It must be recognized that before desirable pasture species can produce large quantities of palatable, nutritious herbage, the soil must be able to supply them with adequate quantities of all plant food nutrients. The general level of soil fertility must be relatively high. Although the practices which may be necessary to maintain a high level of soil fertility in pasture sods may differ from those followed with other crops and may also differ from one section to another, the principle of maintaining an adequate level of soil fertility as a prerequisite to satisfactory herbage production, applies universally.

As pastures become more productive as a result of improved soil fertility relationships and the presence of heavier-producing species, grazing management technique becomes increasingly important. Such practices as rotational grazing, the omission of early spring and late fall grazing, the clipping of undergrazed areas and the spreading of droppings are all practices which are not only beneficial but in many cases essential to the maintenance of high productivity levels.

By directly exercising a considerable degree of control over the first three factors which govern pasture production, the adverse effects of the fourth factor, climate, are greatly reduced.

**Permanent Pastures.** Pasture areas which have never, or only infrequently, been tilled and seeded are included in this category. Ten years' experience with fertilizer topdressing experiments on permanent pasture sods in Massachusetts has shown that, although the composition of the vegetation can be greatly improved and a marked increase in production effected, it is not possible in the great majority of cases to develop and maintain a first-rate pasture by the use of topdressing materials alone. The explanation may be found by examining existing natural soil fertility relationships. The natural level of soil fertility in most Massachusetts pastures is very low, and topdressing applications of fertilizers alone do not raise this level sufficiently high to encourage the establishment and growth of the more productive, desirable pasture species.

**Semi-permanent Pastures.** This includes those plowable areas which are



tilled, fertilized, and seeded to a pasture mixture once every 3 to 6 years. Pastures of this type have given very satisfactory results in Massachusetts and the acreage of such pastures is increasing rapidly. The success of semi-permanent pastures may be largely explained on the following basis:

1. Tillage of the soil, accompanied by adequate fertilization improves the soil's physical condition and raises the level of soil fertility to such a point that nutritious and productive pasture species are able to establish themselves and remain productive for several years.
2. The use of a seeding mixture has permitted the introduction of desirable, high-yielding pasture species which not only increase the total production of pasture herbage but also aid in maintaining a more uniform production of herbage throughout the pasture season.
3. The importance of desirable grazing management practices has been frequently demonstrated on pastures of this type with the result that grazing management technique, in general, is given careful consideration. This favors a more uniform production of a high quality herbage throughout the grazing season and aids in prolonging the life of the seeding.

### COOPERATIVE TOBACCO INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture in Cooperation with the Massachusetts Agricultural Experiment Station

C. V. Kightlinger, U. S. D. A., in Charge

**Black Root-Rot.** (C. V. Kightlinger.) This project, to develop new strains of Havana Seed tobacco which will be highly resistant to black root-rot and acceptable for type and quality of tobacco and producing capacity under Connecticut Valley conditions, is being continued.

Havana Seed 211 is the most acceptable of the new strains of tobacco which have been developed and tested thoroughly in the course of the project so far. It is grown commercially in considerable amounts each year in the Connecticut Valley, and is bought and used in like amounts each year by most of the dealers and manufacturers who deal in and use Connecticut Valley tobacco. It comes near to fulfilling the principal objectives of the project, but it needs some improvement in minor characteristics. Selections within the strain are being made and tested each year, in an attempt to improve the strain in this respect.

New strains are also being produced by crossing the most acceptable selections of Havana Seed 211 and highly approved strains of regular Havana Seed, and selections from the progeny of these crosses and their backcrosses are being made and tested, to provide new material for use in the project, in case the selections of Havana Seed 211 do not possess all the improvements that may be desired.

**Overwintering of Common Tobacco Mosaic Virus in Soil under Natural Conditions.** (C. V. Kightlinger.) One purpose of this project was to ascertain whether common tobacco mosaic virus contained in plant material could overwinter in soil under natural conditions in the Connecticut Valley, and if so, to what extent the virus overwintered in such manner might constitute a source of inoculum for infections of mosaic in succeeding crops of tobacco, under the conditions of the experiment. Another purpose was to ascertain to what extent mosaic inoculum might be disseminated from diseased to nondiseased tobacco plants by means of ordinary cultural practices.

The land used in working the project had not grown any Solanaceous crops and had not had any refuse material of such crops placed upon it for more than

ten years previous to its use for this purpose. Five plots in all were used. One plot, separated from the others by approximately one hundred feet of turf land, was used to grow tobacco for control purposes during the course of the project. Of the four other plots, two were kept fallow, and two were planted to tobacco the first year, whereas all four plots were planted to tobacco the second year, in accordance with plans for the experiment. One plot was used the first year to grow tobacco which was inoculated artificially and completely with mosaic virus as soon as possible after planting, in order to permit the disease to become fully systemic, to provide suitable material for study of the first objective of the project. This plot from which the tobacco was cut and removed and one of the fallow plots on which this same tobacco was placed, were plowed at once and then again the next spring, and were used the second year to grow tobacco for the further study of the first objective. As a result, there were provided for this purpose the second year, one plot which contained only the stumps and roots of systemically diseased plants, and one plot which contained only the tops of the same tobacco. One other plot was used the first year to grow tobacco which had five percent of its plants inoculated artificially with mosaic virus as soon as possible after planting, to provide a suitable setup for the study of the second objective, which was made the first year. However, because of the prevalence of mosaic which developed in this tobacco the first year, this plot from which the tobacco was cut and removed and one of the fallow plots on which the same tobacco was placed were plowed at once and then again the next spring, and were used the second year to supplement the study of the first objective of the project.

One strain of Havana Seed tobacco was used for all purposes of the experiment. All the tobacco received like treatments, except for the special treatments which have been explained.

At the time of plowing for tobacco the second year, samples of upturned stumps and roots and of the upturned tops of the systemically diseased tobacco plants, were taken to determine whether this overwintered tobacco material contained virus capable of infecting greenhouse tobacco plants. Duplicate tests using ten plants each were made for each kind of material collected. All the plants inoculated by hand with water extractions of this material developed mosaic, while duplicate controls consisting of ten plants each developed no mosaic when treated to the same inoculating technique except that sterile water was used instead of water extractions of the upturned tobacco material.

In field tests made the third year of the experiment to ascertain to what extent the mosaic virus overwintered in such manner in soil might constitute a source of inoculum for mosaic in the second succeeding crop of tobacco, special care was taken not to let any cultivating tools touch the plants and possibly thereby disseminate inoculum from plant to plant. And when the tobacco had grown so large that no further cultivating could be done without brushing the plants, counts of the mosaic-diseased plants were made, and were assumed to represent the extent to which the overwintered mosaic virus had served as a source of inoculum in this case. This assumption seemed to be justifiable, inasmuch as the control tobacco which had been cultivated and treated in like manner had developed no mosaic.

In the case of the tobacco grown on the plots where only systemically mosaic-diseased tobacco had been grown the previous year, it was found that out of 1894 plants grown on the plot which contained only the stumps and roots of the preceding tobacco, 16, or .84 of one percent of all the plants, had developed mosaic; and out of 1125 plants grown on the plot which contained only the tops of the preceding tobacco, 9, or .80 of one percent of all the plants, had mosaic. And in the case of the tobacco grown on the plots where the previous crop of tobacco had been completely but probably not all systemically infected with

mosaic, it was found that out of 2129 plants grown on the plot which contained only the roots of the preceding tobacco, 12, or .61 of one percent of all the plants, had developed mosaic; and out of 1232 plants grown on the plot which contained only the tops of the preceding tobacco, 10, or .81 of one percent of all the plants, had mosaic.

In the tobacco grown for use in ascertaining the extent to which mosaic inoculum might be disseminated from diseased to nondiseased tobacco plants by means of cultural practices, 5 percent of all the plants were inoculated artificially by hand, but otherwise the tobacco was treated as tobacco grown for commercial purposes would ordinarily be treated. Counts of mosaic-diseased plants were made just before topping and just before harvest. From counts made just before topping it was found that out of 2122 plants grown on the plot, 191 or approximately 9 percent of the plants had developed mosaic, or 4 percent more than the number of plants which had been inoculated artificially by hand. Counts made just before harvest showed all the plants to have mosaic.

The tobacco grown for control purposes and used for control in connection with both experiments described above, had no mosaic-diseased plants.

## DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

**The Effect of Feeding a Vitamin A Concentrate on Growth and Reproduction in Dairy Cattle.** (J. G. Archibald and C. H. Parsons.) This project has been completed and the results have been published in Bulletin 357.

**The Effect of Complex Mineral and Vitamin Mixtures on Milk Production, General Health, and Reproductive Efficiency in Dairy Cattle.** (J. G. Archibald.) The data have been correlated and summarized, and preliminary reports have been prepared on two of the three long-time feeding trials conducted under this project. Data from the third trial are in process of correlation and summary. Results from the two studies which have been completed do not show any benefits from the feeding of the two proprietary mixtures in question.

**A Study of the Mineral Elements of Cows' Milk.** (J. G. Archibald and C. H. Parsons.) Supplemental iron in the form of iron ammonium citrate, fed to a group of eight cows in the college herd during the winter of 1938-39 did not increase the average iron content of their milk. In fact the tendency was towards a decrease. Large variations were noted in the iron content of the milk between individual cows at any given time, or between samples from the same cow at monthly intervals. Both of these types of variation were noted irrespective of whether supplemental iron was being fed or not. The iron content of most of the samples was of the order of 0.5 mg. per kilogram of milk or less, although there were a few samples where it ran as high as 1.0 mg. per kilo, or even higher.

Some dissatisfaction was experienced with the method used for determining iron and certain refinements and modifications were introduced which gave more uniform values for the samples obtained in the latter part of the season. Because of this and also because the trend toward a decrease in the iron content of the milk when additional iron was fed does not seem logical, it has been decided to repeat the work during the barn-feeding season of 1939-40. Somewhat larger amounts of supplemental iron are being fed this year.

**Investigation of the Merits of Legume and Grass Silage for Massachusetts Agriculture.** (J. G. Archibald and C. H. Parsons.) Results from this project to the end of 1938 together with findings of other workers applicable to conditions



here, have been published in Bulletin 362. Results secured since the bulletin was issued deal chiefly with the use of phosphoric acid as a preservative for grass silage. While it would be unfair to draw final conclusions from one season's work, feeding trials with 28 cows conducted in the winter of 1938-39 indicated that:

1. The phosphoric acid silage was not as palatable to the cows and did not produce quite as much milk as either corn silage or molasses silage. Gains in weight also were less than on either of the other kinds.

2. Phosphoric acid seems to do a better job of preservation than molasses, as the carotene content of silage made with it was somewhat higher than that for a similar lot of molasses silage.

3. Flavor of the milk from cows receiving phosphoric acid silage was pronounced, by impartial flavor experts, superior to the flavor of milk from the same cows when they received either corn or molasses silage.

Approximately 125 tons of phosphoric acid silage has been stored this year, and is now being compared with corn silage in an extensive feeding trial to see whether the results of last year will be confirmed. Approximately 63 tons of molasses silage stored this year will be fed to growing dairy heifers in comparative trials with corn silage.

## DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

**Iodine in the Ration with Reference to the Coli-acidophilus Ratio in the Stools of White Rats.** (James E. Fuller and W. B. Esselen, Jr.) It is recognized that an adequate amount of iodine in food is necessary for the proper nutrition of man and animals. Food materials produced in many localities are deficient in iodine, and this fact has encouraged research workers to investigate methods for increasing the iodine content of food substances. This research suggested the study of the possible effect of increased iodine in food on the intestinal flora of white rats, with special reference to the relative numbers of *Escherichia* (*Bacillus*) *coli* and *Lactobacillus acidophilus*. This is of interest because *L. acidophilus* is considered by many to be desirable in the intestine, and *E. coli* relatively undesirable.

One group of young white rats was given hamburg steak for a month to increase the coli content of the stools, and another group of an equal number of rats was given a cereal diet to increase the acidophilus content. Then each group was divided into four sub-groups and fed as follows: 1, raw milk; 2, raw milk with added iodine; 3, pasteurized milk; and 4, pasteurized milk with added iodine. For several weeks the different milk rations were added to the hamburg and cereal diets respectively, and then for the final several weeks milk alone was given. The amount of iodine used daily for each rat represented what would be a high-iodine ration for humans if it were fed to them in the same proportion in relation to body weight as to the rats. Bacteriological tests made frequently during the course of the experiment showed that total bacteria counts were quite erratic both in individual rats from time to time, and in rats of the same sub-group at any given examination time. There was no evidence that the iodine in the ration either increased or decreased the coli or acidophilus counts, and these counts were quite as erratic as were the total counts. The experiment indicated that iodine in a quantity desirable from a nutritional or a physiological standpoint would not influence intestinal bacteria significantly.

**Indol Production by Escherichia Coli.** (James E. Fuller.) The theory of auto-intoxication is based upon the production, by bacteria in the intestine, of sub-

stances which are absorbed into the body and there cause some poisoning effect. Indol is one of these substances, and it is produced by the colon bacillus which is common in the human intestine. It is known that when plenty of sugar is available for the bacteria, little or no indol is produced. This is especially true when the sugar is dextrose, the form to which all starch and sugar in food is digested in the intestine. Studies were made in culture media on factors that might influence indol production by the colon bacillus. Results: 1, All common sugars (dextrose, lactose, maltose, sucrose), starch, and dextrine checked indol production. 2, Control of intestinal acidity by calcium carbonate or dipotassium phosphate did not check indol production. 3, Acidity did not check indol production unless the acid was concentrated enough to interfere with growth of bacteria. 4, Bile and bile salts did not interfere with production of indol. 5, When *Aerobacter aerogenes* was grown with *Escherichia coli* in a medium containing one-half of one percent of dextrose, the combined cultures appeared to use the dextrose so that the production of indol by the colon bacillus proceeded as if no dextrose had been present. The study on indol production is being continued.

**The Influence of Bacteria on the Oxidation of Ascorbic Acid.** (W. B. Esselen, Jr., and James E. Fuller.) This study has been completed and published in two journal articles: *Journal of Bacteriology* 37:501-521, 1939 (Contribution No. 319); and *Food Research* 4:329-334, 1939 (Contribution No. 326).

**Relationship of Onion Juice to Bacterial Growth.** (James E. Fuller and Ernest R. Higgins.) For many years the belief has persisted that onions and garlic have the power to prevent bacterial growth. Some success has been reported in the use of garlic to prevent spoilage of pickles, and even from the use of garlic in the treatment of tuberculosis. More recently papers have been published reporting the ability of onion and garlic vapors to prevent bacterial growth. The present study was made to determine the value, if any, of onions to control bacterial growth in pickles and relishes. The effect of onion juice in culture media was studied with several species of bacteria, with results as follows: (1) *Aerobacter aerogenes* was entirely resistant to the juice, and (2) *Escherichia coli* was nearly so. (3) *Salmonella schottmulleri*, (4) *Pseudomonas pyocyanea*, and (5) *Staphylococcus aureus* did not grow in concentrations much above 50 percent of juice, but the bacteria were not killed. (6) *Proteus vulgaris* and (7) bacteria of the *Bacillus subtilis* group grew only in low concentrations of juice, and in the more concentrated juice the bacteria were killed. The first four species are human intestinal bacteria; the fifth is from the skin, and can cause food poisoning; the sixth is common in putrefying substances; the seventh is from dust and soil. Live steam weakened the bacteria-controlling property of the juice as compared with sterilization by filtration, and steam-pressure sterilization practically destroyed the property. The juice still could hinder bacterial growth even though experiments showed that the vapors were no longer potent.

**Studies of Cocci from Swimming-Pool Water.** (James E. Fuller and R. H. Guiberson.) Cocci are significant in swimming-pool water because those from the nose and throat can cause infections in pool users, while those from the intestine are less dangerous and probably entirely harmless. When cocci are isolated from swimming-pool water, it is important that they be identified as intestinal or non-intestinal. As a beginning of a study of identification methods, a group of cocci identified as intestinal by commonly used methods were studied further. It was found that a pH value of 10.7 and 15 percent common salt in the medium, respectively, in place of pH 9.6 and 6.5 percent salt commonly used, made it possible to separate the cocci studied into two fairly distinct groups. The study is being continued.



**Streptococci in Swimming-Pool Water.** (Ralph L. France.) Results obtained in this study indicate that the "streptococci" isolated from the water in the college pool came from the body surfaces of the swimmers, and are not of intestinal origin. Further, the evidence indicates that while the bacteria appear as "streptococci" in the preliminary isolation media, biochemical and morphological tests identify the majority as micrococci. Their public health significance remains at present an unknown quantity.

Further biochemical tests will be made on these organisms, particularly their salt tolerance, chlorine tolerance, and ability to grow in a medium with a high alkaline reaction.

**Co-operative Study of Milk Plating Methods with the Food and Drug Division of the State Board of Health.** (Ralph L. France.) A comparative study of media and methods for plating market milk is being made with the Food and Drug Division.

**Laboratory Service.** (Ralph L. France.) Following is a list of the types and numbers of examinations made during the past year.

Milk (bacteria counts).....	893
Ice cream (bacteria counts).....	120
Water.....	123
Miscellaneous:	
Streptococci.....	2
Throat swabs.....	25
Paper.....	8
Ice.....	16
Total.....	1,187

## DEPARTMENT OF BOTANY

### A. Vincent Osmun in Charge

**Effect of Soil Temperature on Gardenia.** (L. H. Jones.) Low soil temperatures induce a chlorosis of gardenia. A more intense form of the malady was associated with a high level of soil nitrogen. Tests with diphenylamine on the almost white leaves gave a strong positive reaction for nitrates, indicating the inability of the leaves to utilize the nitrogen.

In order to demonstrate that the effect of soil temperature on plants in the long hot days of summer is similar to the effect obtained in late autumn, winter, and early spring, a summer series of gardenia plants was set up in the soil temperature apparatus. Chlorosis was obtained at the lower soil temperatures of 55° and 60° F. There was an absence of chlorosis at 65° F. and above. Associated with the appearance of chlorosis was the setting of a great many flower buds, most of them developing into good flowers. Although some growth took place at the lower temperatures, it was very slow. There was no bud set at 65° F. and also very little growth. With the soil temperature at 90° F., the growth was very rapid, with large leaves and no bud set.

It is thus apparent that soil temperature is a factor that not only controls the color of gardenia plants, but also affects the physiological functions of vegetative and flowering phases. The fact that chlorosis appears during the shorter days of the year should not lead to the belief that lack of light is the responsible factor. Any correlation that exists between length of day and chlorosis of gardenia is apparent only when it is considered that length of day plays a considerable role

in the maximum effect that air temperature has on soil temperature.

Some attention has been given to the theory that soil temperature is not in itself a direct factor, but is a governing agent that controls other factors. Spraying chlorotic leaves with an iron solution (5 percent ferrous sulfate) has produced spotted leaves with irregular areas of dark green surrounded by the general chlorotic field. This would indicate that soil temperature either alters the absorption of iron or affects the root system so that, even if the iron is absorbed, it cannot be translocated to the leaves. There is also the fact that growth can be not only slowed down, but actually stopped by low soil temperatures. There is, therefore, cumulative evidence that nutrient absorption and nutrient translocation, either or both, may be governed by soil temperature.

**Root Temperature Effects in a Nutrient Solution.** (L. H. Jones and G. E. O'Brien. Cooperative with Chemistry.) Soybean plants of the Manchu variety were grown in three-salt nutrient solutions maintained at the three thermostatically controlled temperatures of 50°, 70°, and 90° F. Since the air temperature about the plants was the same, the differences in the amount of water transpired and nitrogen absorbed were due to the root temperature environment.

The results showed that the quick lowering of the root temperature from about 70° to 50° F. caused the plants to wilt. Transpiration and nitrate absorption were lowest at 50° F. The figures on nitrate absorption indicated that the optimum root temperature was 70° F. or higher, but less than 90° F. No relationship could be established between the amount of water transpired and the amount of nitrogen absorbed. It is evident that the availability of water as influenced by root temperature can alter the rate of transpiration, a factor which is independent of the evaporating power of the air. The investigation confirms other reports that the amount of solutes, in this case nitrogen, enters the plant independently of the amount of water transpired.

**Plant Containers.** (L. H. Jones.) Fuchsia and heliotrope have proved to be excellent plants as indicators in various types of plant containers. Fuchsia has a characteristic red midvein when nitrogen deficient. When nitrogen is applied, the first noticeable response is the disappearance of the red vein. This has taken place in a time period of 6 days. It may be detected more readily than a change in the greening of yellow-green leaves. Heliotrope in porous clay flower pots develops a matted root system against the wall of the flower pot as shown in the photograph on page 51. Since this response is due to the accumulation of nutrients in this region, the thickness of the mat indicates the zones of fertility in the soil. This mat of roots also may be used to demonstrate the necessity of keeping the pot wall moist in order to protect these feeding roots from drought.

**Study of Diseases of Ornamental Herbaceous Plants Caused by Soil-Infesting Organisms, with Particular Attention to Control Measures.** (W. L. Doran.) Damping-off was well controlled by subirrigation, when the pots or flats of soil, after seeding, were set in shallow pans of solutions until the soil was saturated. Results were better with vinegar or formaldehyde (1.5 quarts or 3 to 4 teaspoonfuls, respectively, per gallon) than with formic acid or pyroligneous acid as used. If soil is too wet before treatment, formaldehyde is to be preferred to vinegar, as it is also with very small seeds which may be injured by the growth of mold on the soil following the use of vinegar. With these exceptions, vinegar gave as good control as did formaldehyde. Formaldehyde, thus applied, was more effective in soils which, before treatment, were not more than 25 percent saturated than in soils which were already 50 percent saturated. It may take longer, however, to subirrigate a completely dry soil, and there was injury to some species by 4 cc. formaldehyde in such soil.

Soil in metal flats with double bottoms, the upper one perforated, was watered from below, with solutions introduced between the bottoms and thus beneath the soil, after seeding. Damping-off was satisfactorily controlled by as little as 2, or even 1 teaspoonful formaldehyde per gallon of water, with some chemical injury in a too dry soil from 4 or even 3 teaspoonfuls.

As little as one teaspoonful formaldehyde per quart of water per square foot, applied from above and worked into soil before seeding, controlled damping-off.

In applications up to those heavy enough to cause chemical injury, damping-off was not controlled by urea, thiourea, diacetone and sulfamic acid. Results were more encouraging with oxyquinoline sulfate and salicylanilide and their use is being further investigated.

**Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment.** (W. L. Doran.) Sand, sand-peat, and sandy soil were compared as rooting media for cuttings of sixteen species. Nine rooted best in soil, six in sand-peat, and only one in sand.

Cuttings of *Cornus florida* L., *Syringa vulgaris* L., *Viburnum Carlesii* Hemsl., *Prunus maritima* Marsh., and *P. subhirtella* Miq. all rooted better if taken in June than if taken later in the summer.

Indolebutyric acid was more effective than indoleacetic acid in improving rooting of cuttings of the seven species with which both were used. All treatments referred to below were with solutions of indolebutyric acid and were for 18 to 24 hours at 18° to 20° C.

Rooting of cuttings of five species was, however, more improved by solutions at initial temperatures of 30° to 35° C. (soon falling to 20° C.) than at an initial and approximately constant temperature of 20° C. Treatment at initial temperatures of 40° C. or higher was injurious.

Dilutions of indolebutyric acid (mg. per liter) which most improved rooting of summer cuttings of the following deciduous species (and of holly and hemlock) and late-fall cuttings of the conifers were: 12.5 mg. for Japanese quince and flowering dogwood; 25 mg. for lilac, Wistaria, American holly, and *Viburnum Carlesii*; 50 mg. for common hemlock, arbor-vitae, four species of Rhododendron, and *Cotoneaster horizontalis* Decne.; 100 mg. for Irish juniper, two species of Chamaecyparis, and two varieties of Norway spruce.

A delayed treatment of cuttings of incense cedar with indolebutyric acid, which was applied fifteen months after cuttings were taken, was very effective in improving rooting.

Treatments effective with softwood cuttings did not affect the rooting of hardwood, winter cuttings of four out of five deciduous species.

Damping-off of seedlings of Carolina hemlock, *Hovenia dulcis* Thunb., and *Stewartia pentagyna* L'Hérit. was not well controlled by seed treatment with red copper oxide.

**Carnation Blight Caused by *Alternaria dianthi* S. & H.** (E. F. Guba, Waltham.) Some features of this project are awaiting further field study before publication is attempted. Meanwhile, extensive breeding is in progress in an effort to obtain suitable varieties resistant to *Alternaria* blight and especially branch rot, caused by *Fusarium dianthi* Prill. & Delacr., a serious parallel carnation disease problem. The work is being carried on in cooperation with the New England Carnation Growers Association and Prof. Harold E. White.

**Chemical Soil Surface Treatments in Hotbeds for Controlling Damping-off of Early Forcing Vegetables.** (W. L. Doran and E. F. Guba, Waltham.) Treatments were applied to the surface of the soil immediately before or after seeding and the results were the same.



Damping-off was well controlled by 2 cc. formaldehyde (in 1 quart water) per square foot of soil. There was no chemical injury when 4 cc. was similarly used but control was good with 3 or even 2 cc. There was good control by 3 cc. whether soil, before treatment, was dry or up to 50 percent saturated. Control was as good when solutions were applied at 10° C. as when they were applied at 55° or 60° C.

A solution containing 4 teaspoonfuls formaldehyde per gallon of water was applied to a row 5 inches wide, immediately after seeds (of sweet peas) were sown. Final stands were much improved by 1 quart of this solution for each 2, 3, or 4 linear feet of row, with best results when 1 quart was applied to 3 feet (or 1 gallon, containing 4 teaspoonfuls formaldehyde, to 12 feet of row).

Vinegar 215 cc. per square foot prevented damping-off without injury. There was, however, injury to some species when 235 cc. was used.

A 1-400 solution of commercial formaldehyde applied at the rate of 1 gallon to 5 square feet of seedbed or 1.89 cc. of formaldehyde per square foot has proved most useful in the control of damping-off of certain vegetables. The solution is applied after the seed is covered with soil. This treatment has not been injurious to the following vegetables: beet, celery, chicory, cucumber, eggplant, endive, lettuce, Romaine, onion, pepper, spinach, tomato, and Swiss chard. The best stands of crucifers have been obtained from the treatment of the seeds with zinc oxide. Lettuce and Romaine frequently have done better with a 1-500 solution of formaldehyde (1.51 cc. per square foot) and with the red copper oxide seed treatment. The use of lukewarm water in making the formaldehyde solution is desirable as a precaution against injury. This method of treating seedbeds to control damping-off is considered an improvement over the addition of formaldehyde dust to the soil before seeding, or over the so-called improved or direct method of adding 6 cc. of formaldehyde per square foot of bed and resting the soil before seeding. This method and dilution (1.89 cc. of formaldehyde per square foot) is safer and more practical in controlling damping-off of the *Pythium* type.

**Control of Greenhouse Vegetable Diseases.** (E. F. Guba, Waltham.) It has been conservatively estimated that about 555 tons of greenhouse tomatoes are lost to production in Massachusetts each year as the result of the tomato leaf mold disease, caused by the fungus *Cladosporium fulvum* Cke. The new Bay State tomato, resistant to the disease (see previous report), has been released for commercial production and has proved highly acceptable. Bay State is characteristically Waltham Forcing but earlier and with rather freely branching or racemose fruiting clusters, both features being derived from *Lycopersicon pimpinellifolium*, one of the original parents and the source of resistance to the disease. Since the original crosses in 1933, desirable fruit size and quality have been added to Bay State by three subsequent crosses with Waltham Forcing. The resistance of Bay State to this serious tomato disease has revived interest in the growing of greenhouse tomatoes for the autumn and winter market and incidentally will reduce substantially the cost of greenhouse management especially required in the growing of other varieties of tomatoes.

**Causes and Control of Decay of Winter Squash in Storage.** (E. F. Guba, Waltham.) The past season has been most favorable for high yields of squash and good keeping. Only occasional occurrences of black rot, caused by *Mycosphaerella citrullina* (Smith) Gross., and bacterial wilt rot, caused by *Bacillus tracheiphilus* EFS., and rare instances of blue mold rot, caused by *Penicillium* sp., have been noted. It has been determined that shrinkage from moisture loss in storage, from harvest to February 1, is approximately 10 percent of the weight at harvest. In the 1938-39 storage season the amount of shrinkage varied but

slightly under different humidity and temperature conditions. In the 1937-38 storage season shrinkage was reduced from 9.2 percent to 7.3 percent when average mean relative humidities of 62 percent and 84 percent and average mean temperatures of 57.3° F. and 45° F. respectively were contrasted; but under low temperature and high humidity the loss from decay was approximately doubled. Decay under low temperature and high relative humidity storage conditions rises rapidly after the first of January.

**Factors Affecting Yield of Onions and their Shrinkage in Storage.** (C. J. Gilgut and W. G. Colby. Cooperative with Agronomy.) Twenty-five lots of onion sets gathered from a number of Connecticut Valley onion growers were grown under the same conditions on a plot of typical onion land to determine the effect on yield and shrinkage in storage of (1) variety and source of seed sets, (2) stage of maturity at time of harvest, and (3) methods of harvesting, curing, and storing. The following conclusions are based on observations made during the growing season and on experimental data thus far collected.

Although, at the time of planting, no visible difference in the quality and uniformity of the different lots of sets on trial was apparent, there was considerable variation in performance. Locally grown Japanese seed sets grew more vigorously throughout the season and significantly outyielded Japanese seed sets shipped into Massachusetts.

Onions harvested after nearly all tops had broken over yielded 30 percent more than onions harvested ten days earlier when approximately 75 percent of the tops were down. In the case of the Connecticut globe type seed sets, later harvesting resulted not only in greatly increased yields, but also in improved quality because of fewer small, objectionable bottle-neck bulbs.

Shrinkage resulting from disease after 75 days in storage ranged from 2 percent in some varieties to as much as 30 percent in others. The average for all varieties indicates that onions harvested when the tops were completely down developed 15 percent more disease in storage than onions harvested 10 days earlier, but this was more than offset by the increased yield. Onions which remained in burlap bags in the field until October 1 before being moved into storage showed approximately 5 percent greater loss from disease than onions placed in storage a few days after harvest.

The bulk of loss due to disease was caused by bacterial soft rot and *Fusarium* bottom rot. At the end of 75 days in storage, the former accounted for 46 percent of the decayed onions; the latter for 48 percent. Bacterial soft rot was more prevalent in the early part of the storage period than other types of decay, but decreased in amount as the storage period progressed. *Fusarium* bottom rot, on the contrary, was less prevalent during the earlier part of the storage period than during the latter.

It is interesting to note that while *Botrytis* neck rot is said to be one of the chief causes of loss in storage, thus far this season only one onion out of 2½ tons examined was affected by this disease.

**Miscellaneous Tests and Experiments.** (E. F. Guba and C. J. Gilgut, Waltham.)

1. *Apple Scab Control.* The apple spraying experiments were intended to determine the relation of sulfur particle size to scab control. The wettable sulfurs were all used on the same sulfur basis by weight.

Six applications were made. All treatments except that at the pink bud stage were combined with lead arsenate, and for the curculio and maggot sprays 4 pounds of lead to 100 gallons of spray were used. There were no significant contrasts in the control of scab in spite of differences in sulfur particle size. Where lime-sulfur was used in the precover sprays the usual injury, dwarfing and scant foliage, developed. The excellent control of scab with insignificant amounts of

wettable sulfurs emphasizes the importance of proper timing and thorough spraying rather than the material used. When the fruit was examined for apple scab, a record of injury by the plum curculio was also made and the results show that bentonite sulfur, as represented by Kolofog, which provided the heaviest deposit and the most persistent adherence of residue, gave the best control of the curculio.

2. *Copper Sprays for Vegetables.* The cucumber plots were destroyed by mosaic before there were any appearances of downy mildew. Some rows remained green longer than others but the untreated plot outyielded all others. Higher yields were not necessarily associated with low percentages of mosaic cucumbers. With melon, downy mildew appeared late and in spite of the disease the highest yield was obtained from the unsprayed row. Drought conditions were unfavorable for tomato foliage diseases; nevertheless, there were wide differences in yield among the different treatments. With celery, 67.4 percent of the leaflets in the unsprayed rows were affected with late blight, as compared to less than 1 percent in the sprayed rows.

### **Diseases of Trees in Massachusetts.** (M. A. McKenzie and A. Vincent Osmun.)

*The Dutch Elm Disease Problem.* In view of the imminence of the Dutch elm disease, which has increased in 1939 with the steady encroachment of the disease to a point in New York less than five miles from the southwestern border of Massachusetts, studies of tree diseases in the field and in the laboratory have accorded special attention to those diseases of elms which superficially are not to be distinguished from the Dutch elm disease.

Present studies of the spread of the Dutch elm disease in the United States indicate new locations for the causal fungus in parts of the States of New York, Connecticut, Pennsylvania, and Maryland in Eastern United States; and at stations in Ohio and Indiana in the Midwest. Connecticut, with 348 affected trees reported for the year, remained the only New England State in which the Dutch elm disease is known to occur. Since the first discovery of the disease in America, approximately 57,000 trees have been removed in the United States because they were afflicted with the pestilence, and about 4,109,300 additional undesirable or dead elms have been removed from zones immediately surrounding infestations. The 1939 figures for the entire country show a decrease of 40 percent in the number of diseased trees as compared with 1938. From the standpoint of Massachusetts, however, the proximity of the disease is particularly disconcerting in spite of the decrease in the number of diseased trees.

Interested agencies, groups, and individuals, including the Federal Bureau of Entomology and Plant Quarantine, the Massachusetts Forest and Park Association, arboriculturists, employees in other State and Municipal departments, and private citizens have supplemented the work of this organized project in collecting specimens from trees showing symptoms resembling those of the Dutch elm disease. On two occasions during the summer, the elms in Berkshire County were the subject of intensive scouting by trained scouts from this Laboratory. Samples of trees suspected of harboring the disease were collected also in Hampden, Hampshire, and parts of Franklin and Worcester Counties. Up to the present time (November 28, 1939) the Dutch elm disease has not been found in Massachusetts. All reports that the disease was present in the State have been investigated and found to be without basis in fact.

Considerable confusion exists as to what constitutes the Dutch elm disease. Any accurate statement relative to the occurrence of the disease must include the laboratory report of cultural isolation of the causal fungus from affected trees. Because of the close association of certain carrier insects with the spread of the causal fungus and the control measures directed against them, statements concerning these insects have sometimes been misinterpreted as relating to the



fungus disease itself. It must be understood clearly that no population of carrier insects, however large, can initiate the Dutch elm disease independently of the causal fungus, *Ceratostomella ulmi* (Schwarz) Buisman. Of course, if the fungus is accessible to a large population of carriers, the spread of infection associated with the disease may be facilitated greatly. Therefore, control of the carriers is essential to any program directed against the spread of the fungus, and the 67 W. P. A. municipal tree projects in operation throughout Massachusetts during the past year had as one objective the curtailment of carrier populations which infest dead and weakened trees or parts of trees. Such programs should prove of considerable value against the day when the Dutch elm disease may be found in Massachusetts. In view of the widespread distribution of the oldest known American infestation of the imported smaller European elm bark beetle carrier in eastern Massachusetts, and the more limited infestation in Berkshire County, Massachusetts faces a serious Dutch elm disease problem on the western as well as the eastern front, even though the disease is not now known to be in the State.

*Other Tree Problems.* Sixty-eight fungus diseases of thirty-three hosts, including eleven diseases of elm, were identified from specimens received for diagnosis during the year.

The Cephalosporium wilt disease of elm has been found to be rather widespread in Massachusetts and has been the subject of field and laboratory investigations over a period of several years. Results have been published in Bulletin 368.

A serious fungus disease of the London Plane-tree, an exotic, hybrid, ornamental sycamore widely planted in parts of eastern United States, has been reported as causing serious damage in New Jersey and certain other locations outside of New England. Numerous inquiries relative to this disease have been received during the year, but thus far the disease has not been found upon the sycamores in New England, although the native sycamore is supposedly susceptible to infection by the causal fungus, *Ceratostomella* sp. Sycamores in this section are subject to the Sycamore Blight, caused by *Gnomonia veneta* (Sacc. and Speg.) Kleb., which commonly affects leaves and twigs. Possibly the recently reported disease, which kills the trees, in part at least, by the growth of a canker, may escape early detection because the public has become accustomed to seeing leaves wither in association with the common blight.

Winter injury was a common cause of tree disorder this year. Deciduous plants as well as evergreens suffered severely from this trouble in addition to serious secondary injury from the effects of the hurricane of September 1938. Injuries traceable to the hurricane continue to be sources of numerous inquiries. In order to facilitate the handling of these inquiries, a series of ten brief circulars has been prepared to supplement the general information on the repair of hurricane damaged trees included in Extension Circular 30. Also, at the request of the Massachusetts Tree Wardens' and Town Foresters' Association, a report on the hurricane in Massachusetts was prepared for their publication, "Proceedings of the Twenty-eighth Annual Meeting, February 8 and 9, 1939."

**Crown Rot of Dogwood.** (C. J. Gilgut.) This disease, caused by *Phytophthora cactorum* (L. & C.) Schroet., is serious to ornamental flowering dogwoods and is present in Massachusetts. The organism kills the bark at the base of the tree, thus girdling it and causing its death. A number of chemicals were determined to be toxic to the organism growing on artificial media. Materials which proved toxic are a solution of methyl alcohol and resin, equal weights of each, Bordeaux paint, aqueous solution of mercuric bichloride 1 to 1000, saturated alcoholic solution of mercuric bichloride, turpentine, malachite green 1 to 1000, copper sulfate solutions 1 to 10 and 1 to 100, Semesan 1 to 1000, and a saturated solution of potassium permanganate. Materials which proved nontoxic are pentachloro-

phenol 1 to 1000, oxyquinoline sulfate 1 to 1000, malachite green 1 to 10,000, methyl alcohol, linseed oil, and shellac. Potassium permanganate solutions at 1 to 1000 and 1 to 100 seemed to have a stimulating rather than a toxic effect.

## DEPARTMENT OF CHEMISTRY

W. S. Ritchie in Charge

### Cooperative Analytical Service. (The Department.)

*Off-Flavored Eggs.* Normal fresh eggs and those having a strong, "fishy" or "sulfury" odor were sent in by the Poultry Department of the College for examination. Chemical analyses have failed thus far to show fundamental differences in composition sufficient to account for the offensive odor.

*Insecticides and Fungicides.* Various samples of flotation sulfur sent in for examination were evaluated by a 300-mesh screen test and the character of the residue. The samples varied from .07 to 4.06 in percentage of material that would not pass a 300-mesh sieve.

*Roach Powder.* A sample was analyzed qualitatively for active ingredient and filler. The sample apparently contained sodium fluoride, a starch product, and a water-insoluble coloring material.

*Lubricating Oil.* Samples of new and used automobile lubricating oils were submitted for analysis. The used oils were from cars and trucks equipped with filters and represented various mileage. After extensive use these oils had "picked up" considerable carbon, gasoline, and mineral matter and their effect on density, volatility reaction, flash and fire points, and ash was considered a measure of contamination.

Some changes in the oils as a result of long-continued use were (1) increased volatility (0.39 to 3.36 percent); (2) lowered flash point ( $442^{\circ}$  to  $265^{\circ}$  F.); and (3) increased ash content (0 to 0.38 percent).

The used oils were treated with eight different clarifying agents and filtered. Activated charcoal yielded a bright clear product superior in appearance to the original unused oil. Bentonite also proved efficient but had less decolorizing action.

### Testing Analytical Methods. (The Department.)

*Determination of Zinc in Foodstuffs.* Work on the dithizone-carbamate method for the determination of zinc in foodstuffs has been continued during the past season with satisfactory results. The original "two step" method, published in 1938, has been improved by incorporating a preliminary treatment with dithizone in an ammoniacal solution for the removal of nonreacting bases and acids and by other minor changes to insure a more definite procedure. The use of wax-coated bottles has reduced the contamination of the reagents but some of the synthetic resins may prove more durable.

Two samples, polished rice and seed rye, together with granulated zinc for the standard were furnished various analysts under the auspices of the A.O.A.C. for collaborative work. As a whole the technique was acquired more readily than was expected, but adequate control was lacking in some instances due to inexperience. Personal differences in reading a visual color comparator lead to the belief that some of the new instruments employing a barrier-layer type of photoelectric cell would be preferable.

*Determination of Boron.* The investigation of dark centers in rutabagas necessitated a continued study of the Dodd method for boron. While this eventually gave concordant results, some modifications were necessary. Other methods are now being studied with a view to securing a simpler process and one less difficult to control.



**The Iron, Copper, Zinc, and Iodine Content of Fruits and Vegetables Used as Human Food.** (E. B. Holland, W. S. Ritchie, and C. P. Jones.) As in previous years various samples (21) of human and cattle foods have been collected and their analysis is well under way. They include cereals, processed human foods, proprietary foods, vegetables, dried citrus pulp, and young succulent grasses and clovers.

**Dark Centers in Rutabagas.** An experiment was conducted with two varieties of rutabagas, American Purple Top and White Cape, in four counties of the State during 1938 to note the effect of borax in preventing dark centers. The extremely wet season may have vitiated the results to some extent, but samples from treated plots showed nearly twice as much boron as from the untreated. Hollow heart, however, was more noticeable than dark centers, which had been characteristic in previous years. No samples showing the disorder were available this season.

**Chemical Changes in Cooking of Vegetables.** (M. E. Freeman and W. S. Ritchie.) Since mealy potatoes are more desirable in most American retail markets, attempts have been made to ascertain the chemical or physical properties of cooked potato flesh that are causally related to this character. Previous workers have observed that in mealy potatoes the cells separate to a greater extent and the moisture content is usually lower.

The fact that the cells of mealy potato tissue separate readily suggested that the pectic materials binding the cells together would be more easily disintegrated and dissolved in mealy potatoes than in waxy potatoes. The careful fractionation and isolation of the pectins in 20 samples (8 varieties) varying widely in texture did not, however, indicate a significant difference between mealy and waxy potatoes. While cooking brought about rapid changes in the pectic material, the extent of these changes as measured by the extraction of pectin did not distinguish the mealy from waxy potatoes.

Additional information concerning some characteristic properties of potato pectin was obtained. In the preparation of samples for pectin analyses, a mild heat treatment designed to inactivate the destructive enzymes was found to alter the pectin fractions. Rapid drying of sliced potatoes in a current of warm air was superior. In potatoes the three pectin fractions generally described for plant material were not clearly defined. The data led to the suggestion that potato pectin can be adequately defined by two fractions: (1) a fraction soluble in ammonium salts but insoluble in hot water; (2) a fraction easily dispersed by hot water but not by cold water. Further details of this investigation have been submitted for publication in *Food Research* under the title "Pectins and the Texture of Cooked Potatoes."

A number of investigators have attempted to correlate mealiness with low moisture content, high dry matter content, and/or high starch content. While the majority admit that there is probably a fairly high correlation, there are other conclusions to the contrary. About 200 tubers (7 varieties) were individually tested for mealiness and analyzed for moisture. The moisture contents ranged continuously from 87.4 to 69.1 percent; consequently the three classes of high, intermediate, and low moisture had to be arbitrarily defined. Three degrees of mealiness, high, medium, and low, were independently estimated. When the data were tabulated under these two classifications, it became apparent that there was a high degree of correlation between low moisture content and mealiness in these potatoes.

However, waxy potatoes cannot be made mealy simply by expelling more water by prolonged cooking. There appear to be unknown factors influencing the relative ability of tubers to retain moisture during the cooking process.

Three methods for determining the water-binding properties of starch, raw potatoes, and baked potatoes have been tested. The Dumanski method, if carefully followed, was found to be rapid and accurate for starch and other materials that do not contain water-soluble solids. The method could not be applied to raw or cooked potato tissue with much success. The dilatometric method was long and tedious and quite unreliable unless the last traces of dissolved air were removed from the sample by vacuum during a long process of intermittent freezing and thawing. The calorimetric method proved to be rapid and reliable with all types of potato material. The results of these methods agree very closely when applied to starch and raw potato pulp.

Starches from seven varieties of potatoes varying in mealiness all adsorbed about .3 gram of bound water per gram of dry material. Analyses of a few varieties of potatoes (raw) yielded a similar value. No significant differences were found between mealy and waxy varieties. Studies are now being made on baked potato tissue under these experimental conditions.

Other methods are being applied that may give additional information regarding the moisture relationship in raw and cooked potatoes.

Continuing the work reported earlier with peas, spinach samples were obtained to determine the changes, if any, due to storage and cooking after preservation by canning and freezing.

The fresh spinach was sent to the laboratory where it was dried at low temperatures as a control sample. Additional spinach from the same field was canned and frozen and so stored for three, six, nine, and twelve months. At the end of each of these storage periods three cans of spinach were opened and drained. Half the sample was dried without cooking. The other half was cooked in half of the liquor from the cans and then filtered and dried. The unused half of the liquor was kept as one sample and the filtrate from the cooking process was a second sample. The same procedure was followed with the frozen samples. Frozen spinach (one and one-half packages) was dried immediately after thawing. A second sample of one and one-half packages was thawed and cooked with a definite volume of distilled water after which it was dried. This cooking water was saved for comparison with the liquor samples described above. These were analyzed for total solids, ash and nitrogen. The samples of dried spinach were subjected to methods of proximate analysis and the methods proposed by Horwitt, Cowgill and Mendel.

In general, results obtained by proximate analysis do not show any outstanding changes. The ash in all stored samples was somewhat lower than in the original sample. It has been suggested that perhaps the blanching process removed some of the ash before the samples were processed. Long standing in the cans apparently softened the tissue, with the result that ash was removed more easily in cooking liquors. The protein was consistently higher in the cooked samples and perhaps represents a real difference. The material soluble in ether increased in the canned spinach while the frozen samples showed no change. Crude fiber apparently did not change significantly in either canned or frozen samples when stored.

It appears that changes, if any, in the spinach, when stored either frozen or canned, are not apparent by such a method of analysis.

A second method of analysis has been suggested by Horwitt, Cowgill and Mendel, which considers the solubility of food constituents using  $H_2O$ ,  $N/10$   $HCl$ , 0.50 percent  $Na_2CO_3$ ,  $N/10$   $HCl$ +pepsin, and 0.50 percent  $Na_2CO_3$  + trypsin as solvents.

The water-soluble nitrogen showed no significant change as a result of storage. The values for the frozen samples were higher than those for the canned samples, indicating possibly a rupture of the cells and therefore greater extraction. Both

the cooked, frozen, and canned samples had lower results with the water extraction, probably due to heat coagulation of the protein and in the canned samples a loss from the liquor.

The enzymatic digestion using HCl and pepsin showed no effect resulting from the continued storage period. In fact, all pairs (cooked and raw) were in very good agreement.

In vitro digestion using  $\text{Na}_2\text{CO}_3$  + trypsin showed no real differences but indicated that 76.5 percent of the protein was digested regardless of length of storage or method of preservation.

In both cases, the insoluble ash and the insoluble residue were higher in the cooked than in the raw samples regardless of the time of storage. If solubility means availability there is more of these in the raw samples than in the cooked.

This work is now complete for a sample high in starch, one high in protein, and one high in roughage. These results will be evaluated as a whole before further work is attempted.

**Investigations of Some Physical and Chemical Properties of Mosaic Viruses.** (M. E. Freeman.) The investigations on potato mosaic under this project can be carried out only during the fall and winter months. Because of delays occasioned by hurricane damage in the fall of 1938, no experiments were attempted during the winter of 1938-1939.

**Lignin and its Relation to the Absorption of Minerals by Plants.** (Emmett Bennett.) The chemistry of lignin is being studied to determine its role in plant metabolism, to ascertain possible relationships with other plant products, and to understand the properties which make it possible for this substance to function as it does in the soil.

Lignin was isolated from corn cobs by an alkali method. The purified product was electrodialyzed in a Mattson cell. A partial study was then made of the solvate obtained by dispersing lignin in a solution of sodium hydroxide. Electro-metric titration of the solvate with hydrochloric acid yielded data which produced a symmetrical curve with two inflection points. The first point came at about pH 9 and the second at about pH 5. Precipitation occurred and seemed complete at  $\text{pH } 5 \pm 0.1$ .

Lignin dispersed in a solution of equal parts of alcohol and acetone and titrated in the same way behaved differently. The addition of lignin alone to this solution lowered the pH to a point below which precipitation occurred in the previous solution. Precipitation did not occur upon lowering the pH to 2.5.

These data indicate that lignin prepared in the manner described may differ from humates in the soil in at least two ways: (1) Neither charge nor hydration appears to be the stability factor; (2) Solvation does not occur at a pH below the precipitation zone.

Lignin appears to be different from other incrusting materials such as hemicellulose in that these substances usually have the two stability factors, charge and hydration.

*Precursors of lignin.* The work discussed in the last report has been written up and two papers have been submitted for publication.

*The Digestibility of Lignin.* Previous work with rats showed a high percentage recovery of lignin and indicated a decrease in the digestibility of nitrogen. In 1939 the digestibility of lignin and the effect of a diet of high lignin content on the digestibility of nitrogen was determined.

Rats were fed a complete diet containing 15 percent of lignin which had been isolated from corn cobs. An average of  $93 \pm 3$  percent of the lignin was recovered.



The average digestion coefficient for nitrogen was  $90 \pm 3.5$  in the control diet and  $82 \pm 2$  in the lignin diet.

These data indicate that lignin is not only practically indigestible but that it may affect the digestion of nitrogen.

**Effect of Storage and Processing on Carbohydrates of Some Varieties of Edible Onions.** (Emmett Bennett.) The work of the project was continued as outlined with the exception that the use of "seed" (Yellow Globe Danvers) onions was discontinued.

"Set" (Ebenezer) onions were stored (A) in a warm room, (B) in a basement, and (C) in a commercial storage from November 15 to February 27. Storage A represented relatively high temperatures and low relative humidity; C, relatively low temperatures and high relative humidity; and B, conditions intermediate between A and C. The temperature and relative humidity were recorded regularly. Representative samples were obtained for analysis before and after storage.

The following results were obtained from the crop of 1938. The onions from storages A, B, and C shrunk 19, 10, and 10 percent respectively and yielded 29, 62, and 87 percent of marketable onions. The shrinkage was caused principally by respiration; apparent rotting was negligible in all cases. The sprouts represented 69, 37, and 12 percent respectively.

The dry matter of the fresh onions contained 59 percent sugars, of which 28 percent was reducing sugars and 72 percent was sucrose. During storage in B and C this proportion changed to 49 percent of reducing sugars and 51 percent of sucrose; and in A, to 34 percent of reducing sugars and 66 percent of sucrose. This change was accompanied by a loss of total sugars, averaging about 15 percent, with a minimum of about 11 percent in storage B and C, and a maximum of 24 percent in storage A. In general, the amount of total sugars lost by respiration determined the amount of shrinkage during storage. The weight of fresh onions which contained an amount of total sugars equal to the loss during storage in B and C was found to be practically equivalent to the weight of onions which was lost by shrinkage. This relationship was not true in storage A.

Sucrose appeared to be the reserve carbohydrate. In storages B and C the rate of respiration was sufficiently slow to allow reducing sugars to accumulate at the expense of sucrose. In A, however, the rate of respiration was so rapid that glucose was oxidized as rapidly as formed.

While the sugar changes noted in the onions from storages B and C were almost identical, the percentage loss from sprouting was 25 higher in B than in C. This was believed to be due principally to the lower temperatures in storage C.

The foregoing data indicate the following trends in the Ebenezer onion:

1. The sugars appear to be mainly reducing sugars and sucrose, which may make up approximately 60 percent of the dry matter.
2. Sucrose is the reserve sugar, and prior to storage over 70 percent of the total sugars may be in this form.
3. Common storage practices produce an increase in reducing sugars and a decrease in sucrose.
4. Storage conditions may exist which produce sprouts but which do not significantly increase the rate of respiration in the onions which do not sprout.
5. Slightly lower temperatures may retard sprouting without significantly altering the rate of respiration.

**The Progressive Decomposition of Haddock Muscle.** (W. S. Ritchie and Philip N. Simon.) Little is known concerning the systematic physico-chemical changes taking place during the decomposition of the muscle proteins of fish. This study is an attempt to elucidate some of the changes in the colloidal nature of the

material by means of peptization with neutral salt solutions as decomposition progresses, and by the isolation and identification of the decomposition products of haddock muscle stored under conditions of poor refrigeration.

Much of the effort so far has been confined to an attempt to determine the optimum conditions under which haddock muscle proteins may be peptized by neutral salt solutions. Observations will be made on changes in the peptization values during the storage of haddock muscle. Preliminary data point to an increase in the percentage of total nitrogen peptized by sodium chloride solutions, as the storage time is prolonged. The greatest peptization values for sodium chloride solutions appear to lie between concentrations of 1.5 and 2.5 normal, other concentrations following a typical peptization curve.

Isolation and possible identification of the decomposition products of haddock muscle are being attempted from fillets stored at 10-12° C. for 20 days. Samples taken at frequent intervals during storage demonstrated a regular increase in volatile nitrogen. However, samples distilled under reduced pressure with magnesium oxide yielded more volatile nitrogen than did identical steam-distilled samples, the difference in value increasing with storage time.

## THE CRANBERRY STATION East Wareham, Massachusetts

H. J. Franklin in Charge

### Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.)

*Fire Beetle (Cryptocephalus incertus)*. Over a hundred acres, mostly in Bourne, Wareham, and Rochester, were found more or less seriously infested with this pest in the summer of 1939, the infestations in all cases having continued from 1938. Eighty acres were treated very successfully by spraying somewhat after mid-August with 3 pounds of lead arsenate in 100 gallons of water, 250 gallons to the acre.

A few of the beetles were found on August 7, and 25 of them to 50 sweeps of an insect net were taken on August 11 on a bog from which the winter water was let off early in April. A few were found on another early-drawn bog by August 13.

*Cranberry Weevil (Anthonomus musculus)*. Application early in June of 100 pounds per acre of bran poisoned with 5 pounds of sodium fluosilicate and moistened with water failed completely as a control for the beetles. A like application with oil in place of the water gave the same result.

Alorco cryolite, 9 pounds in 100 gallons of water, applied 400 gallons to the acre on July 31, killed 80 percent of the newly emerged adults.

*Cranberry Spittle Insect (Clastoptera saint-cyri)*. A considerable infestation of the adults of this species was killed completely by dusting with 100 pounds to the acre of 4 percent rotenone derris (without an activator or wetter). Nine pounds of cryolite in 100 gallons of water, applied 400 gallons an acre, had no noticeable effect on them.

*Colaspis Root-worm (Colaspis brunnea var. costipennis)*. Adults of this pest of grape, strawberry, apple, timothy, and corn were found abundant on a bog near West Wareham in late June and early July. They fed freely on the cranberry foliage, blossom buds, and flowers. Their grubs had evidently eaten the fibrous roots of the vines somewhat and eaten the bark off along the vines just below the surface of the sand. A new brood of the grubs, half grown, was found in the cranberry turf of the affected area in the fall, so the species evidently hibernates as a grub. Over half an acre of the bog was in poor condition from the

work of the insect, some of it with few or no vines, showing that the infestation had been there several years.

The writer observed a similar, but less important, infestation of this insect on a bog in South Carver about ten years ago. The grubs are much like those of the Cranberry Rootworm (*Rhabdopterus*) and the beetles are somewhat smaller than those of that pest and have yellow stripes on the wing covers.

*Hill Fireworm* (*Tlascalea finitella* (Walker)).<sup>1</sup> This common name is given here to a worm which, this season, seriously infested an area replanted in the spring of 1939 at Greene, Rhode Island. The worms destroyed all the foliage on cranberry vines in the hills on about an acre and a half and did much harm on two and a half acres more. They did not attack any area well vined over. They did most of their work late in July and left a thick mass of their frass and dropped leaves on the sand around the bases of the defoliated plants of each hill. From one to three worms were found on the sand and close to the bases of the plants of each hill. They spun silk very copiously around the lower parts of the plants on which they worked and made extensive loose tubes of it in which they hid. They incorporated sand freely in these tubes on and near the ground and also their frass which they dropped in remarkable abundance.

These worms were very active and jumpy when disturbed. Most of them were full grown by August 2 and some had pupated. When mature, they enveloped themselves in a cocoon of silk and sand on the surface of the sand and soon pupated in it. Nearly all of them had pupated by August 16. The moths emerged from August 20 to September 5. Some pupae remain at the time this is written (November 27), but they seem to be parasitized.

The descriptions of the mature worm, pupa and moth follow:

**Worm:** Length, about five eighths of an inch. Head mostly blackish. Cervical shield blackish, with a broken yellow stripe along the front margin. Body dark brown, striped lengthwise on the back and sides with about eight narrow and broken pale yellow stripes. Venter without stripes. Back and sides with noticeable scattered pale hairs.

**Pupa:** Slender, about two fifths of an inch long. Head end and wing covers dark olive green. Abdomen mostly chestnut brown. Caudal segment dark brown, with a small hook on each side of the apex recurved ventrad.

**Moth:** Length to wing tips, about three eighths of an inch. Wing expanse, about three quarters of an inch. Forewings dark gray above, with cross tufts of black or black-tipped erect scales near the base, about a third of the length from the base and somewhat beyond the middle of each; uniformly smoky below. Hindwings pale with smoky front and outer margins. Head (except eyes), palpi, and basal parts of antennae dark gray. Thorax dark gray above, light gray below. Legs dark gray. Dorsum of abdomen dark gray with fringes of pale yellow along the hind margins of the middle segments; venter colored similarly but with pale marginal hind fringes on all the segments.

Very little of the biology of this species has been known hitherto. It ranges from Canada to Florida but is more common in the South.

The writer observed a less important attack of this pest several years ago on a bog newly planted that spring in East Middleboro. That infestation, though untreated, failed to appear the next year.

*Atlantic Cutworm* (*Polia atlantica*). An outbreak of this species was described in the last annual report of the cranberry station.<sup>2</sup> The pupae mentioned there as remaining in late December lived through the winter, moths emerging on May 21 and 23, 1939. The description of the moth follows:

<sup>1</sup>Identified by Mr. Carl Heinrich of the U. S. National Museum.

<sup>2</sup>Mass. Agr. Expt. Sta. Bul. 355, p. 39, 1939.



Length to wing tips, about eleven sixteenths of an inch. Wing expanse, nearly an inch and a quarter. Head mostly medium brown. Thorax mostly medium brown dorsally but with a whitish collar in front margined behind with black. Thorax below and legs light to dark gray. Abdomen mostly gray or smoky brown, with much pale yellow at the tip on the males. Forewings variegated above with gray and medium brown, with a narrow streak of black running out from the base and touches of black near the middle and toward the outer margin, and with a very irregular pale yellow or whitish line running across the outer end a little back from the border. Hindwings smoky above, gradually lighter toward the base. Underside of wings grayish brown of varying shade, that of the hind pair whitish toward the base of the hind side and with a darker dot near the center.

*Gypsy Moth (Porthetria dispar)*. Numerous applications of various derris dusts (with and without activators and wetters), up to 100 pounds an acre of 4 percent rotenone derris (without activator) and of derris dusts with moderate admixtures of pyrethrum powder failed to give satisfactory kills of the largely grown caterpillars of this pest. Dusting to control them in any way with rotenone materials seems entirely impracticable.

*Cranberry Root Grub (Amphicoma vulpina)*. Studies of the life history of this pest in recent years have shown that the grubs remain in the soil four or five years depending on their luck in obtaining food. Due to this variation, grubs hatched in several different years often come to be associated in the soil.

The cyanide treatment, used extensively for this pest with more or less success for several years, is somewhat dangerous when applied carelessly, sometimes fails to be effective enough, and takes too much time. A more satisfactory insecticide control is therefore much desired. For this reason, the following treatments were tried on infested plots late in April:

1. Sodium fluoride up to a pound in 50 gallons of water, applied a gallon to a square foot.
2. Semi-colloidal arsenate of lead up to 12 ounces in 50 gallons of water, applied half a gallon to a square foot.
3. Sodium arsenite up to half a pound in 50 gallons of water, applied a gallon to a square foot.
4. Sodium fluoride up to 1000 pounds an acre, applied as a dust.

The plots were examined late in August and it was found that none of the sodium fluoride or arsenate of lead treatments had reduced the grubs materially. The vines on the areas dusted with sodium fluoride were badly injured and most of the water applications of this chemical had the same effect. Most of the vines and 75 percent of the grubs on the plot treated with 6 ounces of sodium arsenite in 50 gallons of water and all the vines and all the grubs on the plot treated with half a pound in 50 gallons were killed.

On October 13, a pint of dichlorethyl ether in 50 gallons of water was applied to different infested plots at rates of 1, 2, and 4 quarts to a square foot. These plots were examined November 20; the odor of the chemical was still strong in the soil of all of them and the conditions of the grubs were as follows:

1. Treated with 1 quart to a square foot—20 alive, 12 dead
2. Treated with 2 quarts to a square foot—31 alive, 33 dead
3. Treated with 4 quarts to a square foot—0 alive, 31 dead

The cranberry vines on the last plot were badly injured.

*Cranberry Fruit Worm (Mineola vaccinii)*. The season's experience in controlling this pest with rotenone-bearing sprays and dusts, in both experimental work and commercial practice, was in complete accord with that of previous years. A pound and a half of soap in the spray mixture, however, was found enough.

The dust containing 2 percent of rotenone and an activator and wetter was again beautifully effective when used twice, at the proper times, at the rate of 100 pounds an acre. Derris dusts of one and a half and one percent rotenone content with activators and wetters, used twice at 100 pounds an acre and well timed, failed to give satisfactory control. Some of the cranberry growers used 50 pounds to the acre of 4 percent rotenone derris dust without an activator and were well pleased with their results.

Alorco cryolite, 6 pounds in 100 gallons, 400 gallons an acre, and cryolite dust, 30 pounds an acre, were used in Carver on July 15 and again on July 25, times when rotenone materials were effective. The fruit worm was controlled almost completely without material injury to vines or fruit, though the first spray seemed to dwarf the berries a little. Samples of the fruit, scooped from the treated areas on September 9, were analyzed for fluorine residues by the Fertilizer and Feed Control Division of the station at Amherst. The fluorine residue on berries from the sprayed plot was .0023 grains per pound of fruit; from the dusted plot, .000945 grains per pound of fruit. When these residues are compared with the legal tolerance of .020 grains per pound of fruit set for fluorine, the danger in this connection from using cryolite seems negligible. It should be noted, however, that over 4 inches of rain fell in a single storm the last of August in the region where these treatments were applied. The rainfall otherwise between the use of the cryolite and the picking of the samples was light.

On August 10, a bog in East Sandwich with a third of the berries already infested with fruit worms was sprayed with 6 pounds of cryolite in 100 gallons of water, 400 gallons an acre. The control obtained was excellent, the worms doing very little further harm while they took all the fruit on untreated adjoining areas. The berries were picked September 19 and had a fluorine residue of .00084 grains per pound of fruit.

It may be best to use rotenone materials, in spite of their higher cost, in the first treatment for the fruit worm, because they are somewhat safer and because they will at the same time check the blunt-nosed leafhopper, the spittle insect, and the second brood of the black-headed fireworm. The second treatment probably should be with cryolite dust because of the low cost for material and application — only about \$4.50 an acre. The dust leaves less residue than the spray (see analyses above). It is less likely to harm the crop at the time of the second treatment than it is when the first is applied.

*Black-headed Fireworm (Rhobobola).* The second brood of this insect was treated very successfully on a number of areas with about 50 pounds to the acre of 4 percent rotenone derris dust without an activator.

*Blunt-nosed Leafhopper (Ophiola).* On July 6, an area with a leafhopper infestation of 310 to 50 sweeps of the net was dusted with a diluted derris dust containing one and a half percent of rotenone, camphor oil as an activator, and a wetter, 95 pounds to an acre. It was examined July 16 and then had only one hopper to 50 sweeps of the net.

On July 11, an area with 450 hoppers to 50 sweeps was dusted with a diluted derris dust containing one percent of rotenone, peanut oil as activator, and a wetter, 100 pounds to an acre. There was a considerable rain on this area for 15 minutes in the morning and another of the same duration in the afternoon on July 12. Only 26 hoppers to 50 sweeps remained on July 16, the kill having been 94 percent. Another area treated and examined on the same dates and in the same way, except that 91 pounds of dust an acre and camphor oil as an activator were used, showed a kill of 94 percent. In relation to their effectiveness, these treatments seem to be as cheap as any that have been tried on this pest so far, the cost of materials and application being about \$10.00 an acre. Judging



by these results, it seems probable that 50 pounds of 4 percent rotenone derris (without an activator or wetter) an acre will be very effective, but this remains to be tried.

Extensive commercial control of this leafhopper began in 1933. Observations of the results obtained since then indicate that, once control is established, treatment is not necessary on most Massachusetts bogs oftener than once in three years if it is thorough when it is applied. Evidently the hoppers do not travel far en masse and come onto bogs of average size from surrounding uplands very slowly. An infestation of over three hoppers to 50 sweeps of an insect net calls for treatment at any time. Because of the rising cost of pyrethrum products and the falling cost of rotenone dusts and the blanket effectiveness of the latter on the fruit worm, the black-headed fireworm, and this leafhopper, the time for treatment may shift in many cases from the last week in June to around July 10.

*Pyrethrum Dusts.* There have been many puzzling failures of these materials to control cranberry pests. Checkings of stated pyrethrin content lead to the conclusion that these have probably nearly always been due to inferior quality of the material used. The purchase of pyrethrum from large local distributors who can have the pyrethrin content of the dust they are handling determined is a protection here.

*Prevalence of Cranberry Pests.* The relative general abundance of cranberry pests in Massachusetts in the 1939 season was as follows:

1. Gypsy moth more abundant in Plymouth county than in 1938, being quite troublesome in some localities; extremely destructive on the middle and outer Cape, even more so than in 1938.
2. Blunt-nosed leafhopper (*Ophiola*) even scarcer than last year, due to general treatment.
3. Cranberry fruit worm (*Mineola*) generally less prevalent than normal, less so than in 1938.
4. Black-headed fireworm more prevalent than last year but widely controlled by disease.
5. Firebeetle somewhat reduced from 1938 (see above).
6. Green and brown spanworms slightly increased from 1938.
7. Cutworms definitely less than last year and less than usual.
8. Cranberry girdler (*Crambus*) and Spittle insect (*Clastoptera*) about the same as in 1938 and rather less than normal.
9. Cranberry root grub (*Amphicoma*). There seems to be a slow general increase of this pest from year to year in spite of effective treatments.
10. Weevil (*Anthonomus*) about as last year, more prevalent than normal.
11. Tipworm (*Dasyneura*) widely prevalent.

*Control of Cranberry Bog Weeds.* (Chester E. Cross.) During the months of June to September, inclusive, 730 weed control plots were treated. Of these, 410 were treated variously with water-white kerosene and the rest with the following, alone and in some combination: Sodium chloride, calcium chloride, sodium chlorate, sodium arsenate, copper sulfate, ferrous sulfate, ferric sulfate, cyanamid, and ocean water. Results of 1938 work were also examined. The following findings from all this are of particular interest.

1. Water-white kerosene, 800 gallons an acre, applied in early November with a watering can, eradicated a thick lot of rice cut-grass (*Leersia*) nicely.
2. A large number of plots was used to compare the weed control values of the kerosenes of the following producers: Atlantic Refining Co., Cities Service Refining Co., Colonial Beacon Oil Co., Gulf Oil Corp., Shell Oil Co., Socony-Vacuum Oil Co., and Texas Co. These concerns very kindly loaned the Cranberry Station drums to hold the kerosenes. No definite relation was found

between the performance of these oils and the analyses provided by the producers. All the plots treated in June, July, and August showed some cranberry vine injury, but the Cities Service and Colonial products did definitely more harm than the others. The Gulf, Shell, and Atlantic kerosenes burned the vines least. All the kerosenes seemed to have about the same power to kill weeds.

3. An attempt was made to find more precisely the best ways to apply kerosene. The watering can distributes the oil much faster than hand sprayers and therefore tends to make heavier and more effective applications, but it is harder to secure an even and complete coverage with it. The same kerosene applied to equal areas in equal amounts with a watering can and a sprayer burned the cranberry vines to the same extent.

4. Bushes of the hoary or speckled alder (*Alnus incana*) up to 2½ feet tall were killed readily at any time during the summer with half a pint of kerosene poured about the base, and a pint killed bushes up to 6 feet tall, these shrubs, like the coarse bramble, being very root tender to this oil. The foliage of the treated bushes remained green from 2 to 4 weeks and then suddenly turned brown and dry; the coarse bramble is apt to stay green for a month after the treatment and may even bloom before it dies. The small bushes may be killed by spraying the tops with kerosene, but large ones were not much affected by such spraying even when it was heavy.

5. Ferric sulfate, 2400 pounds to an acre, eradicated sensitive (*Onoclea*) and feather (*Dryopteris*) ferns completely and 95 percent of horsetail (*Equisetum*). It did not injure the cranberry vines much early and late in the season, but was very harmful to them in July and August.

6. Ferrous sulfate mixed 9 to 1 with sodium chloride and placed in single large handfuls at the bases of royal and cinnamon ferns (*Osmunda*) completely eradicated them with less injury to cranberry vines than was caused by controls previously advocated.

7. Sodium arsenate, 1½ pounds in 100 gallons of water applied lightly in August, was very effective in eradicating partidge pea and false pimpernel.

8. July applications of ocean water showed that 3200 gallons an acre were necessary to completely destroy haircap moss. The moss showed no recovery 2½ months after this treatment. The cranberry vines were not harmed by it.

No bog flooded by the tide of the September 1938 hurricane had any living haircap moss in 1939.

9. The conclusion of last year that a fine spray of 100 pounds of sodium chloride in 100 gallons of water is safe to use in treating the wild bean (*Apios*) if less than 200 gallons to the acre is applied was confirmed. Injury to the cranberry vines from this spray has always been due to the use of excessive amounts rather than to the concentration. The nozzles must be held high enough to prevent driving too much of the material into thick foliage.

10. About 100 tests of pulverized and granular cyanamid were made on 42 kinds of bog weeds. Wherever the weeds were killed, the cranberry vines suffered also.

**Engineering Projects.** (C. I. Gunness and H. J. Franklin.) The study of home cold-storage of cranberries carried on in 1936, 1937, and 1938 and the trial of wind machines for protecting bogs from frost, begun in 1938, were continued, the Cranberry Station cooperating with the Department of Engineering. See the report of the Department of Engineering.

## COOPERATIVE CRANBERRY INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture, in cooperation with the Massachusetts Agricultural Experiment Station

H. F. Bergman, Senior Pathologist, U. S. D. A. In Charge

**Development of Strains of Cranberry Resistant to False Blossom.** (H. F. Bergman and W. E. Truran.) Berries from crosses made in 1938 were sent to the U. S. Horticultural Station, Beltsville, Md., where the seeds were germinated and the seedlings grown. From a total of 353 fruits 8,233 seeds were obtained which produced 6,337 seedlings. In July 1939 there were 6,291 plants. These will be taken to New Jersey and set out on a bog in 1940. Because of the lack of bog area for use in testing hybrid seedlings no crosses were made in 1939.

**Studies on Flower and Fruit Production.** (H. F. Bergman and W. E. Truran.) Studies to determine the effect of oxygen content of winter flooding water on flower and fruit production have previously been made. Previous observations have shown that the average flower production in the Early Black, Howes, and McFarlin varieties, under favorable conditions, is about four flowers per upright. Flower production in Early Black on section 14 of the State Bog, in 1939, was about the normal average. In Early Black on the Star Bog and in McFarlin on the State Bog flower production was less than the average by one flower per upright. Elsewhere on the State Bog the difference was greater, amounting to about one and a half flowers per upright in Howes on section 13 and to about two flowers per upright in Early Black on section 4 and in Howes on section 7. A correlation with weather conditions could not be determined from available data.

The average percentage of fruit set in any of the three varieties, under favorable conditions, varies from 30 to 35. The set in Early Black on section 14 in 1939 was less than half this average. The highest percentage of fruit set, on the State Bog, was 18.6 in McFarlin, the lowest 7.6 in Howes, both on section 13. The low percentage of fruit set appears not to be correlated with the oxygen content of the winter flooding water. It seems possible that the low rainfall during July 1939 may have had an effect on the setting of fruit and may partly explain the variation in set in different locations on the State Bog. The Howes vines on section 13 were on higher ground than elsewhere and might be expected to have had the least water supply; the McFarlin vines were in one of the lowest spots on the bog and probably had the best water supply. The water supply of vines in other locations on the State Bog was intermediate. This is in agreement with the observed set on vines in the different locations. Furthermore, the percentage of fruit set by flowers on uprights from large terminal buds was less than on uprights from medium or small terminal buds in all locations on the State Bog except in McFarlin on section 13. This is in conformity with the suggestion that the reduction in the percentage of fruit set may have been due to a lack of water. The proportion of uprights with three or more flowers per upright is greater in uprights from large terminal buds than in uprights from medium or small terminal buds and a lack of water would affect the set of fruit on uprights with three or more flowers more seriously than on uprights with only one or two flowers.

**Spraying Experiments for the Control of Rosebloom.** (H. F. Bergman and W. E. Truran.) Bordeaux 4-1-50 and 5-2-50, a red copper oxide-bentonite mixture 2-2-50, and yellow copper oxide 1½-50 were each applied once (June 12) on duplicate plots on a bog badly infected with rosebloom. Bordeaux 5-2-50 gave the best control. Within three days after the spray was applied diseased shoots had turned black and shriveled, and no unaffected or only partly killed diseased shoots could be found. Bordeaux 4-1-50 was only a little less effective



than the 5-2-50 and was superior to either the red or yellow copper oxides. Both the red and yellow copper oxides were much slower in action than bordeaux mixture and did not kill out the rosebloom as completely as did bordeaux. A week after rosebloom had been killed out by bordeaux mixture, living unaffected or only partly killed diseased shoots could be found on plots sprayed with either red or yellow copper oxide.

**Spraying Experiments for Cranberry Rot Control.** (H. F. Bergman and W. E. Truran.) Spray tests were run on four bogs, on plots of 1/20 acre area. All sprayed plots received two applications, at the rate of 250 gallons per acre; the first when

Treatment	Bog	Number of Plots	Average Percentage Rot		
			Oct. 1	Nov. 1.	Dec. 1
Bordeaux 5-2-50 (high Ca).....	State S 8	2	1.0	2.8	10.1
Bordeaux 5-2-50 (high Ca).....	State S 14	4	1.3	4.9	12.7
Bordeaux 5-2-50 (high Ca).....	No. 3	4	8.9	16.5	26.8
Bordeaux 5-2-50 (high Ca).....	No. 7	4		4.7	10.1
Bordeaux 5-5-50 (high Ca).....	No. 9	3	3.6	9.3	13.3
Bordeaux 5-2-50 (high Mg).....	No. 9	3	5.4	10.0	14.2
Bordeaux 5-2-50 (high Mg).....	State S 8	2	0.8	4.9	11.5
Check*.....	State S 8	3	1.4	7.6	18.3
Bordeaux 5-3-50 (high Ca) + ½ lb. zinc arsenite... State S 8	State S 8	2	1.0	3.8	13.8
Check*.....	State S 8	2	2.7	12.0	24.3
Bordeaux 5-3-50 (high Ca) + ½ lb. zinc arsenite... No. 3	No. 3	2	9.0	16.3	28.7
Bordeaux 5-3-50 (high Mg) + ½ lb. zinc arsenite... No. 3	No. 3	2	11.6	21.1	31.2
Bordeaux 5-3-50 (high Ca) + ¾ lb. zinc arsenite... State S 8	State S 8	2	0.9	2.8	11.7
Check*.....	State S 8	2	1.6	8.0	16.9
Bordeaux 5-3-50 (high Ca) + ¾ lb. zinc arsenite... No. 7	No. 7	2		3.8	9.2
Check*.....	No. 7	2		27.8	35.8
Bordeaux 5-3-50 (high Mg) + ¾ lb. zinc arsenite... No. 7	No. 7	2		5.2	12.1
Check*.....	No. 7	2		21.1	37.2
Bordeaux 5-3-50 (high Ca) + 1 lb. zinc arsenite... State S 8	State S 8	2	0.9	3.5	13.1
Check*.....	State S 8	2	1.7	6.6	14.8
Cuprocide — bentonite.....	No. 7	3		4.3	9.5
Cuprocide 54Y (1 ½-50).....	State S 14	2	1.1	3.7	10.9
Check*.....	State S 14	2	1.4	8.0	16.2
Cuprocide 54Y (2-50).....	State S 14	2	1.2	4.0	10.3
Check*.....	State S 14	2	3.1	10.0	19.8
Cuprocide 54Y (1 ½-50).....	No. 3	2	9.1	18.8	30.2
Cuprocide 54Y (2-50).....	No. 3	2	9.2	15.7	27.4
Cuprocide 54Y (1 ½-50).....	No. 9	3	6.2	12.3	14.2
Phenothiazine 2-50**.....	State S 14	2	1.4	6.4	15.4
Check*.....	State S 14	2	1.5	7.3	15.2
Phenothiazine 2-50.....	State S 14	2	2.2	7.2	16.7
Check*.....	State S 14	2	3.5	11.7	21.4
Check.....	State S 8	4	2.5	10.1	19.1
Check.....	State S 14	5	2.2	8.8	17.1
Check.....	No. 3	5	17.6	34.7	44.5
Check.....	No. 7	5		25.8	38.5
Check.....	No. 9	5	39.7	52.8	56.5

\*Figures here given apply only to plots indicated on line above; in all other cases values for check plots as given at bottom of table apply.

\*\*No wetting agent.



the flower buds were just ready to open, and the second when the petals had fallen from most of the flowers. The results are shown in the table.

The degree of rot control obtained by the use of the several spray mixtures was greatest during the period from October 1 to November 1 and thereafter declined, sometimes markedly so, because of an acceleration in the rate of spoilage of the berries from so many of the sprayed plots after November 1. The acceleration in the rate of spoilage after November 1 seems not to be correlated with spray treatment, as the same thing was observed in berries from one or more plots sprayed with any one of the several spray mixtures used and also in berries from plots not sprayed. In some instances it appeared to be correlated with local conditions on the bog but this could not be established in all cases.

**Blueberry Disease Investigations.** (H. F. Bergman and W. E. Truran.) Isolations of a fungus causing "wilt" on two bushes of unselected hybrids at the State Bog were made at intervals during the growing season. Both bushes are badly diseased and are known to have been diseased for the last three years at least. *Phomopsis* was isolated consistently from both diseased leaves and stems and appears to be the causal organism.

## DEPARTMENT OF DAIRY INDUSTRY

### J. H. Frandsen in Charge

**Nutritive Value of Chocolate Milk.** (W. S. Mueller and N. L. Keyock.) The nutritive value of chocolate-flavored milk is being studied by animal experimentation. A chocolate syrup which is practically free from theobromine, cocoa fiber, and cocoa fat was compared with a product which contains these substances in ordinary amounts. In both cases the chocolate milk was made from one part of syrup to ten parts of fluid milk (3.5 to 4.0 percent butter fat). Plain milk served as an additional control. Three groups of eight rats each were fed for five weeks.

In general, the rats on the plain milk and those on the special chocolate milk were the extremes, with the rats on ordinary chocolate milk about midway between. The rats on the plain milk diet gained least in weight, were the most active, excreted the most urine, and the pH of the urine was lowest. Here, however, the consistency ends, for the rats on the ordinary chocolate milk showed a slightly higher acidity of urine than the plain milk group, while the figure for the rats on the special chocolate milk was very much lower. The figures for specific gravity of urine were highest for the plain milk group and lowest for the rats on the ordinary chocolate milk.

More data are necessary before the results can be interpreted.

**The Effect of Cocoa upon the Digestibility of Milk Proteins.** (W. S. Mueller and L. D. Lipman.) The purpose of this study was to determine whether or not the addition of cocoa had any adverse effect on the digestibility of milk proteins. Both "in vitro" and animal feeding have been used in this study of three different cocoa powders: a Dutch-process, an American-process, and a blend of Dutch and American cocoa powders.

Experiments in vitro showed that, as the concentration of the cocoa blend was increased from 1 to 2.5 to 4 percent, the digestibility of the milk proteins was reduced 3.1, 8.2, and 12.4 percent, respectively, after four hours' digestion. The addition of 4 percent Dutch cocoa or American cocoa reduced the digestibility of the milk proteins 11.8 and 13.7 percent, respectively. As the percentage of butter fat was increased from 0 to 2 to 4 percent, the digestibility of the milk proteins of a chocolate milk containing 4 percent of American cocoa was reduced

13.6, 12.9, and 12.5 percent respectively. When reconstituted milks were used, the reduction was 16.7, 13.7, and 11.4 percent for skim milk, part skim milk, and whole milk. As the butter fat content of the chocolate milk was increased, the digestibility of the milk proteins tended to increase.

In feeding experiments, white rats were able to digest 85, 71, 69, and 71 percent, respectively, of the protein when the feeds contained milk powder, milk powder plus 4 percent American cocoa, milk powder plus 4 percent Dutch cocoa, and milk powder plus 4 percent American cocoa and 2 percent cocoa fat. The digestibility of the milk proteins was reduced only 7 percent by the Dutch and 6 percent by the American cocoa and appeared to be unaffected by the cocoa fat.

#### **Nutritive Value of Milk Flavored with a Water Extract of Cocoa. (W.S. Mueller.)**

The purpose of this study is to determine whether a water extract of cocoa has the same effect as cocoa powder on the nutritive value of the milk. The following diets were fed to three groups of eight rats each: Plain whole milk, whole milk plus 3 percent cocoa, and whole milk plus 6 percent of concentrated water extract of cocoa, with sugar, sodium alginate, and minerals added to all three. The concentrated water extract was made from 50 grams of cocoa per 100 c. c. of water, and enough was added to the milk so that the rats received the extract obtained from the same amount of cocoa that was fed to the animals on the cocoa powder diet. The principle of the paired feeding method was used through a period of 12 weeks. Animals receiving the plain milk and the milk plus cocoa extract made about equal gains in weight, which were higher than the gains made by the animals receiving milk plus cocoa powder. After the animals had been on test for eight weeks, the extract group was more active than the control group and the cocoa powder group was the least active of the three. A decrease in the volume of urine was noted for the cocoa extract group, and their urine was higher in acidity than that produced by the plain milk diet. On the other hand, the urine from the animals receiving cocoa powder was lower in acidity than that of the control group.

The cocoa powder used in this experiment contained 2.5 percent cacao red, while the water extract of the same cocoa contained only a trace. The results of this study as well as previous nutritional studies indicate a correlation between the digestibility of the chocolate milk and the amount of cacao red in the chocolate flavoring material. This phase of the study is being investigated further.

#### **Improving the Flavor and Keeping Properties of Milk and Some of Its Products. (W. S. Mueller and M. J. Mack.)**

This project deals chiefly with antioxidants for milk and some of its products. The antioxidative properties of various cereal flours have been described in a paper published in *Food Research* 4 (No. 4):401-405, 1939 (Contribution 337).

The antioxidative properties of various sugars are now being investigated. Sugar itself has antioxidative properties and is also a suitable carrier for the antioxidative substance obtained in extracts from oat and corn flour and other materials. Results to date indicate that the antioxidative property of sugar is affected to a greater extent by the refining process than by the kind of sugar.

Cocoa was found to contain a powerful antioxidative substance which could be removed in the water or alcohol extract. The concentrated extract proved to be an effective antioxidant for milk when used alone or in conjunction with a carrier such as skim milk powder. Decolorizing the water extract of cocoa, however, removed most of its antioxidative properties.

The addition of .05 percent of d-glucoscorbic acid and butyl ester of tyrosine prevented an oxidized flavor in susceptible milk.

#### **The Effect of Aging Treatments on Gelatin and Other Ice Cream Stabilizers. (W. S. Mueller.)**

An explanation for the effect produced on gelatin solution by

the higher initial aging temperature was sought by studying properties of gelatin which are likely to be influenced by the gel structure or which would serve as an index to the colloidal behavior of the gelatin. In addition to studies of viscosity, gel strength, optical rotation, and light scattering, which have been described previously, studies were made during the past year of electrical conductance, gold number, and effect of agitation.

The higher initial aging temperature of 68° F. had no significant effect on the velocity of the hydrogen ion through the gelatin gel when compared with an aging temperature of 38° F. for the entire period. However, the higher initial aging temperature decreased the velocity of chromate ions through the gelatin gel when compared with the lower temperature. The decreased rate of migration of chromate ion through the higher initially aged solution suggests a more closely knit structure. The rate of the hydrogen ion was not affected, probably because of its smaller size.

Gold number determinations must be made with very dilute gelatin solutions, which may explain why the higher initial aging temperature did not increase the protective action of the gelatin.

Agitation of the gelatin solution while it was held at the higher initial aging temperature was found to increase the gel structure. If an increase in viscosity retards gel structure building, then it may be expected that agitation within limits will facilitate gel structure formation in that more frequent collisions of gelatin micelle may occur.

Several other ice cream stabilizers were compared with gelatin with respect to their response to high aging temperatures. Water solutions of karaya gum, oat flour, sodium alginate, and agar-agar were initially aged at 68° F. for five hours. Agar-agar was the only substance affected by the higher initial aging temperature. Both apparent and basic viscosity were increased when the high initially aged solution was compared with a solution aged only at 38° F. However, the increase was more pronounced for the apparent viscosity.

**The Use of Egg Solids in Ice Cream.** (M. J. Mack.) Egg solids have been used in ice cream since the very beginning of the business. The effect of egg yolk on the properties of ice cream was studied here some years ago when only batch freezers were used in the industry. Further work appeared necessary to see whether egg yolk solids were desirable in ice cream made on a continuous freezer. A study of the egg products known as egg powder "blends" also seemed desirable.

The conclusions from the work done during the past year were summarized in a recent article entitled "Egg Solids," by M. A. Widland and M. J. Mack, published in the October 1939 issue of the Ice Cream Trade Journal. Egg yolk solids improved the flavor, body, and texture of ice cream. Such defects as coarse texture and weak or crumbly body are less likely to occur when the egg solids are used. The product also causes the ice cream to appear creamy and smooth when melting and helps to eliminate defects in melting appearance.

The egg yolk blends, which are products containing dextrose, skim milk powder, or egg albumin mixed with dehydrated egg yolk, are of value only to the extent that they contain egg yolk. The use of these products instead of ordinary dehydrated egg yolk should be avoided. Methods of analysis which are suitable for determining the percentage of yolk solids in a powdered egg product are discussed in the paper mentioned above.

**Sodium Alginate as a Stabilizer for Ice Cream.** (M. J. Mack.) In previous annual reports, it has been shown that this stabilizer is satisfactory for use in ice cream. Since each stabilizer has somewhat different characteristics, the advisability of combining some of the common stabilizers for use in dairy products should be of interest. Preliminary results indicate that certain combinations



might be worked out which may prove superior to the use of one stabilizer alone. The study of different combinations of vegetable stabilizers is being continued.

**Utilization of Whey By-Products.** (J. H. Frandsen and Myer Glickstein.) Various difficulties have been encountered in the effort to perfect a fermented whey drink. When a double fermentation process is used, whereby the whey is fermented first in an open vat, then in capped bottles, either too much or too little CO<sub>2</sub> is likely to be produced. If the conditions are just right for the production of CO<sub>2</sub>, the time factor becomes troublesome. When the capped bottles are held for some time in storage, the whey becomes more acid and the flavor begins to deteriorate. The yeast cells apparently autolyze to some extent and produce further off-flavors. If in-the-bottle pasteurization is resorted to earlier in the process when just sufficient gas is produced, the dead yeast cells again give rise to objectionable flavors. Further work now in progress should develop a method whereby the activity of the yeast cells can be retarded just enough to prevent any off-flavor.

Other products made from whey, such as whey honey and whey candy, have been developed to the extent that they have commercial possibilities.

**A Study of the Efficiency and the Practicability of the Paper Milk Bottle.** (J. H. Frandsen and M. A. Widland.) All paper bottles examined for micro-organisms gave plate counts well within the standard of one colony per c. c. capacity, as suggested by the American Public Health Association. The micro-organisms that were isolated were harmless saprophytes probably introduced into the containers by the water used in making the paper.

It was found that the volume taken up by the average 12-quart case for glass bottles is about 2700 cubic inches, whereas the volume of paper cases ranges from 740 to 1250 cubic inches, which means a saving of from 53 to 72 percent in storage space. Furthermore, a case of 12 quarts of milk in paper containers is 50 percent lighter than the same amount in glass. Work done also shows a marked saving in refrigeration costs in the case of paper containers.

Paper bottles seem to have no deleterious effect upon the flavor of milk, and even afford some protection against the development of "sunlight" flavor.

## DEPARTMENT OF ECONOMICS

Alexander E. Cance in Charge

**Land-Use Problems in Massachusetts in Relation to a Balanced Program of Land Utilization.** (David Rozman.) A preliminary analysis of land-use factors has been prepared for about one-third of the towns in the Commonwealth, where the relationship between the types of soil, topography, rural roads, and buildings was projected against the existing system of land utilization. This analysis is further considered in the light of local economic and social conditions as reflected in the general movement of the population, available employment opportunities especially in local industries, and trends in land values and taxation, as an indication of the best type of land-use pattern fitting any particular locality.

The results of the investigation completed for Worcester County indicate that out of a total area of about one million acres 15.6 percent is now being used for crops and plowable pasture, 11.5 percent is in stony and woodland pasture, and 63.3 percent is in various types of forest growth; while swamps and wasteland account for 1.3 percent, water bodies occupy 3.7 percent, and settled, commercial, and industrial areas make up 4.6 percent. From the standpoint of the soil analysis and classification, 30.9 percent of the county area is found to be of good adaptabil-



ity for agricultural development, represented mostly by soils both moist and of good texture; 33.4 percent of only limited adaptability; and 27.4 percent unsuitable for regular agricultural utilization, on account of being either too rough and stony or too wet or dry. The correlation of soil types and topographical conditions with present land uses by individual areas indicates the extent and character of adjustments to be carried out in a community under existing local economic and social opportunities.

The results of this study are being put to practical use in connection with the town rural policy committees which are being organized for the purpose of comprehensive land-use planning in rural areas of the Commonwealth. In forty-five towns where these committees have been organized, information obtained in this study has been used as a basis for working out a detailed program of local planning and land-use development.

## DEPARTMENT OF ENGINEERING

### C. I. Gunness in Charge

**Cranberry Storage Investigation.** (C. I. Gunness, H. J. Franklin, and C. R. Fellers.) The work on storage was continued through the 1939 season. Berries were held at 35° and 45° in cold storage and in two screen houses operated by growers. The results obtained were consistent with the results obtained in former years. The storage losses on berries stored from September 10 to November 10 under the three conditions, 35°, 45°, and common storage, were 2.7, 5.5, and 11.3 percent, respectively; and from September 10 to November 30, the losses were 6.7, 9.0, and 17.0 percent in the corresponding storages.

**Frost Protection on Cranberry Bogs.** (C. I. Gunness.) The work on frost protection on cranberry bogs through the use of a wind machine was continued during the past year. The machine was originally set up as a stationary unit on one side of the bog. During the past season it was mounted on a turntable with the plan of placing it in the center of a dry bog. So far it has been used only on the side of the bog. While the results obtained are quite encouraging, it is felt that insufficient data have been obtained to warrant a statement as to the efficiency of this type of frost protection.

**Poultry House Investigation.** (C. I. Gunness and W. C. Sanctuary.) A study of the use of electric brooders in insulated and noninsulated colony houses was started this fall. An insulated house will be heated by an electric heater and in two noninsulated houses the floor is heated by means of soil cable in an attempt to keep the litter dry. Another part of the study will be devoted to the effectiveness of insulation in providing a dry, comfortable laying house.

## DEPARTMENT OF ENTOMOLOGY

### Charles P. Alexander in Charge

**Investigation of Materials which Promise Value in Insect Control.** (A. I. Bourne and W. D. Whitcomb, Waltham.)

**Oil Sprays for Dormant Applications.** Climatic conditions during the late winter and early spring of 1939 were characterized by low temperatures and heavy

snowfall in March and cold, wet, and generally disagreeable weather during most of April. These combined to retard plant development and produce a season 10 to 14 days later than normal, while frequent high winds and sudden changes of temperature interfered with the application of dormant and delayed dormant sprays.

The infestation of European red mite was very light throughout most of the State and was practically nonexistent in most of the college blocks. On the other hand the overwintering eggs of all species of orchard plant lice were very abundant, and in the college blocks the infestation was the heaviest for many years. Counts from 50 typical branches of both McIntosh and Baldwin trees showed 9,635 eggs on 918 inches of twig on McIntosh, or an average of 10.5 eggs per linear inch; and 6,225 eggs on 683 inches of twig on Baldwin, an average of 9.1 eggs per linear inch.

In a cooperative project with the Dow Chemical Company, tests were made, in the college orchard, of the ovicidal value of various oil sprays; one containing dinitro-ortho-cyclo-hexylphenol (DNOCHP), the oil having a viscosity of 110 sec. Saybolt (the commercial Dowspray Dormant); a similar oil containing dinitro-orthocresol; and a combination of a light oil, of 50 sec. Saybolt, and dinitro-ortho-cyclo-hexylphenol. These sprays were prepared and furnished by the Company. A home-made stock solution of a petroleum oil similar to that used in the commercial DN spray above, combined with the DNOCHP powder and emulsifier, was also prepared and applied. Tests were also made of a commercial spray of this type supplied by the California Spray Chemical Company (Nitro-Kleenup), and of a spray material consisting of a sodium salt of dinitro-orthocresol manufactured by the Standard Agricultural Chemicals, Inc. (Elgetol) and reported to contain no oil. All these sprays were applied while the trees were in dormant condition.

Comparison of sprayed trees and unsprayed checks indicated no mortality to fruit or leaf buds nor any retardation of bud development. An application of a commercial DN spray to a few young trees as the blossom buds were breaking, however, was followed by considerable injury to both fruit and leaf buds. All of the sprays proved very toxic to aphid eggs.

Tests of both the commercial DNOCHP sprays and the home-prepared emulsion were carried on, in collaboration with Mr. Robert E. Huntley of Hanover, in several commercial orchards and private estates in Plymouth County. In most of the orchards rosy apple aphid had been so prevalent during recent years that serious damage had been caused and in many cases the crop was practically worthless. In these tests the sprays again demonstrated the fact that when thorough coverage of the trees was secured very few aphids appeared, whereas unsprayed trees showed from 10 to 50 aphids per bud.

The Huntley estate offered the opportunity to observe for the first time the results of dormant application of commercial DNOCHP spray on a wide range of deciduous ornamentals including birch, catalpa, elm, hawthorn, lilac, maple, oak, poplar, and willow including English laurel-leaf pussy willow, a tender variety quite susceptible to spray injury, as well as a dozen varieties of evergreens including arborvitae, cedar, fir, juniper, pine, spruce, yew, and broad-leaved types such as box, laurel, and rhododendron. Very little, if any, damage was noted on the deciduous ornamentals sprayed, but very general injury, varying in degree from slight burning to serious defoliation, resulted on practically all types of evergreens. In addition to furnishing a very efficient control of those species of aphids which had in the previous season attacked these ornamentals, the sprays showed promising results against oystershell scale, elm scale, and tulip scale. European red mite was so scarce throughout that area that no reliable data could be secured.

*Control of Bud Moth with Dormant Sprays.* In cooperation with the Dow Chemical Company and H. A. Priest, nine blocks of trees at Fruit Acres, Gleasondale, infested with the bud moth, were sprayed with combinations of dinitro-ortho-cyclo-hexylphenol (DNOCHP) and dinitro-orthocresol in oil, furnished by the Dow Chemical Company; and sodium dinitro-cresylate, and oil emulsion plus nicotine sulfate, furnished by the owner. Approximately 5000 gallons of spray were applied to 600 trees in the experiment. Application was started on April 23 when the buds were in the silver tip stage but was discontinued at noon because of wind and completed on April 24. Three count trees were selected from each plat and an adjoining unsprayed block was used as a check. A bud examination was made on these trees on May 24-25 when most of the trees were in bloom, and the fruit was examined at the regular harvest period for the variety.

In comparison with a bud infestation of 62 percent and fruit infestation of 23.86 percent in the check, all treatments gave excellent control of the bud moth. Considerable injury occurred, especially to leaf buds on one-year-old twigs and also to fruit buds. This injury was most serious where DNOCHP in oil was used on Gravenstein, Yellow Transparent, and McIntosh. Russet trees sprayed with a tank-made mixture of the same materials showed little or no injury. Injury was much more severe on large trees where the drip and drift from the upper branches caused excessive drenching of the lower branches. The DN cresol mixtures appeared least injurious to the trees and gave satisfactory control of the bud moth.

*Summer Sprays for Apples.* Tests of these materials were conducted in cooperation with the Departments of Pomology and Botany. The widespread damage caused by the hurricane of September 1938 throughout most of the fruit-growing sections of the State naturally led to a study of modifications of the spray program to reduce as far as possible the danger of spray injury to weakened trees and at the same time retain an efficient control of disease and insect pests. Although the hurricane injury in the test block was not so extensive as in more exposed sections of the college orchard, there had been sufficient injury to warrant the use of this block for such studies.

The tests included commercial lime-sulfur at a reduced strength of  $1\frac{1}{2}$  gallons per 100 with spray catalizer, similar tests of lime-sulfur at reduced strength with hydrated lime to retard breakdown, two combinations of lime-sulfur and wettable sulfur at half strengths, wettable sulfur at full strength throughout the season, and a wettable sulfur with orthex sticker. All of the above combinations were used in the pre-blossom and calyx sprays followed by wettable sulfur in the four subsequent applications. The standard schedule of lime-sulfur 2 gallons per 100 in the pre-pink, pink, and calyx sprays, and wettable sulfur thereafter, was used as the basis of comparison. Lead arsenate was omitted in the pre-pink application but was included in all others. The dosage was 3 pounds per 100 gallons in the pink and 3d cover sprays; 4 pounds per 100 gallons in the calyx, 1st and 2d cover sprays; and 2 pounds per 100 gallons in the 4th cover spray. Linseed oil was used in the 1st cover spray.

Examination of the block in early June showed noticeable dwarfing and crinkling of leaves in the trees given the standard schedule. This condition was also present, but to a noticeably less extent, on trees sprayed with lime-sulfur at reduced strength with spray catalizer and lime. The trees which had received the combinations of lime-sulfur and wettable sulfur at half strengths showed no injury up to that time. This was also true where wettable sulfur alone or with orthex sticker was used. Up to that time scab was being successfully controlled in contrast with the unsprayed checks where the foliage was already showing heavy infection. Later in the season when all the trees received wettable sulfur,



the new growth showed no spray injury, and on the trees sprayed with lime-sulfur the late growth was composed of large, flat, normal leaves typical of the foliage on trees which received wettable sulfur throughout the season and in sharp contrast to the small, malformed leaves which received the lime-sulfur application. (See photograph on page 49.)

The crop on the Baldwin trees was very light and uneven. Many of the trees had no fruit and those which produced even a light crop bore most of the apples on the west side of the trees, a possible reaction to the hurricane. The McIntosh trees on the other hand fruited heavily and the crop developed to good size and excellent color. The record of the McIntosh crop at harvest indicated that liquid lime-sulfur at reduced strength was measurably safer to foliage without losing its effectiveness against scab. When lime-sulfur was diluted to half the usual strength (1 gallon to 100) and combined with wettable sulfur, it checked scab satisfactorily and caused no appreciable burn. Spray catalizer acted as a protective agent when used with the lime-sulfur-lead arsenate combination and in a large measure reduced the customary lime-sulfur injury to foliage.

**Control of Striped Cucumber Beetle.** (W. D. Whitcomb, Waltham.) In the experimental planting at Waltham in 1939, the striped cucumber beetle was normally abundant, averaging about 40 beetles per hill on untreated cucumbers and 10 per hill on untreated cantaloupes. More than 75 percent of the beetles were found on cucumbers, thus further emphasizing the preference for this crop.

In general, the influence of the beetle infestation on the yield of fruit was not significant. Continued dry weather prevented the development of bacterial wilt even in the presence of a larger number of beetles, and a heavy infestation of melon aphid was responsible for a general infestation of cucumber mosaic.

In these experiments, treatments were made seven times between June 17 and July 15, while four additional applications were made between July 27 and August 26 to protect the vines until yield records were secured. Under these conditions the most effective materials in reducing the beetle infestation were:

Calcium arsenate-red copper oxide-flour-talc 10-6-10-74

Copper rotenone-talc 4.75 percent copper and .8 percent rotenone

Cube-talc 0.75 percent rotenone

Calcium arsenate-talc 1-14

Calcium arsenate-monohydrated copper sulfate-lime 10-20-70

All of these dusts reduced the beetle population 80 percent or more on cucumbers, and 90 percent or more on the cantaloupes.

Of these materials the calcium arsenate-red copper oxide and the calcium arsenate-monohydrated copper sulfate were the most effective on cucumbers, but the latter caused slight to moderate foliage injury and was much less satisfactory. Applications of fibrous talc alone gave 79 percent protection but showed the lack of a toxic ingredient, while wettable deris spray was ineffective.

In direct comparisons copper oxychloride dust and calcium arsenate were more effective against the beetle with talc as the carrier than with hydrated lime, but a better yield was obtained from vines treated with dust in which lime was the carrier. Calcium arsenate with red copper oxide was more effective on cucumbers, but calcium arsenate with copper zeolite was superior on cantaloupes, and the yield from the cucumber vines dusted with the copper zeolite mixture was the best.

Dusts containing rotenone and those containing calcium arsenate were both effective against the striped cucumber beetle; but better yields were obtained where the calcium arsenate dusts were used and, since they are cheaper, they are preferred.

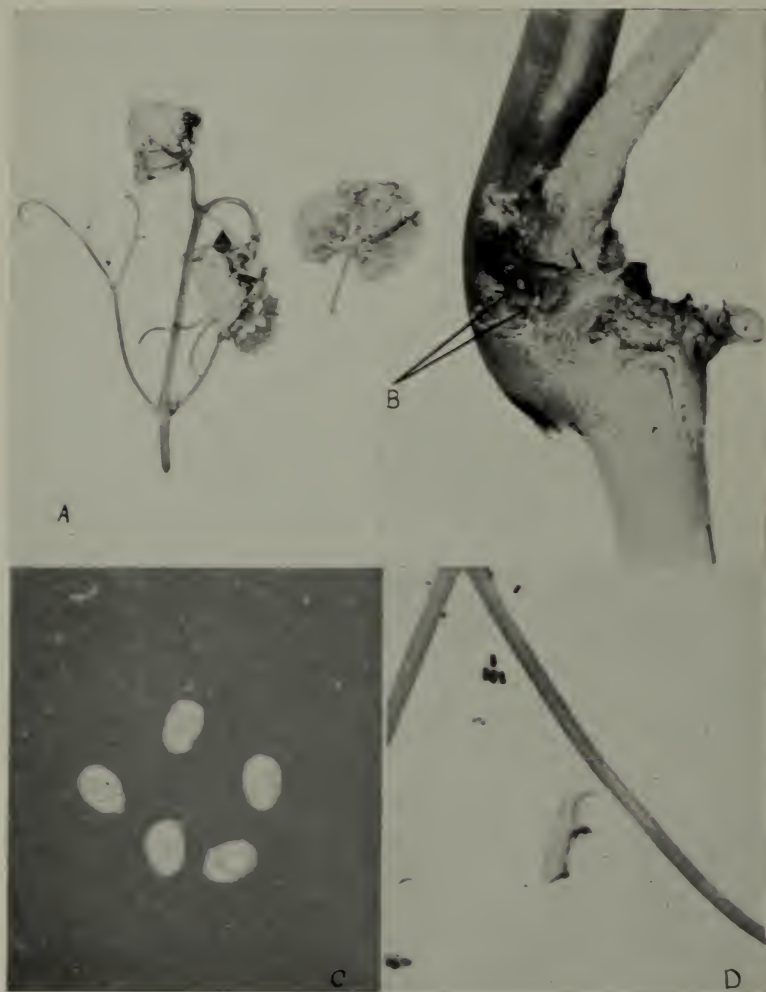




Injury to Apple Foliage Following Pre-Blossom Applications of Lime-Sulfur

LEFT: Uninjured foliage from Baldwin tree sprayed with wettable sulfur-lead arsenate combination throughout the season. Note abundance of foliage and retention of even the small, earliest leaves.

RIGHT: Baldwin foliage dwarfed and distorted as the result of the use of lime-sulfur-lead arsenate spray in pre-blossom and calyx applications. Note comparatively scanty foliage due to loss of most of the early season leaves. The full-sized leaves at the tip represent growth which has taken place since the calyx application. (See page 48.)

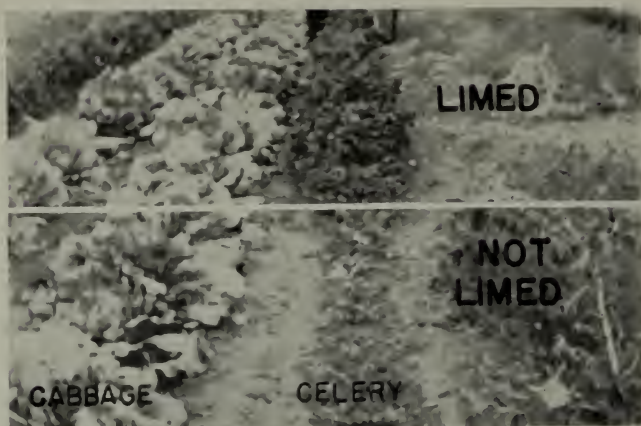


#### Grape Plume Moth

A. Tip of grape shoot, showing the typical injury; B. Eggs in natural position on grape cane; C. Eggs enlarged  $15\times$ ; D. Pupa enlarged  $2\frac{1}{4}\times$ . (See page 64.)



Root systems in porous clay pots tend to concentrate against the pot wall outside the soil mass. When the pot wall gets dry, the adjacent root system may also suffer from drought. Keeping the pot on a moist surface protects the root system. (See page 22.)



Cabbage and Celery on Limed and Unlimed Plots

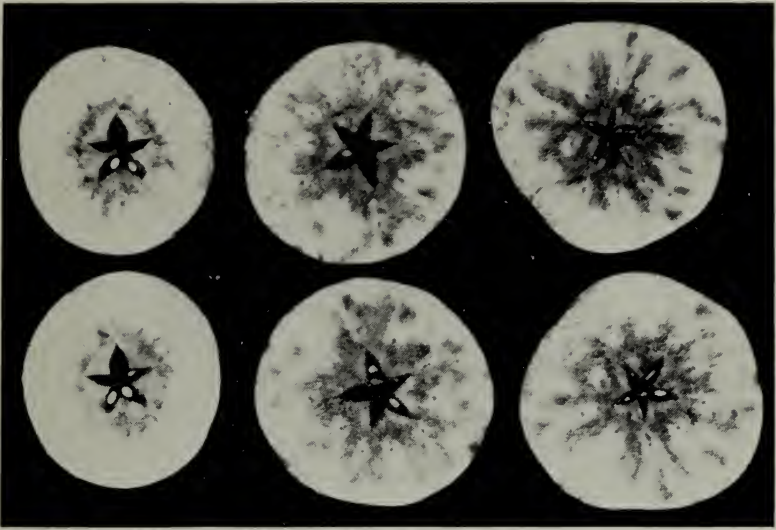
Celery showed marked response to liming, while cabbage grew equally well where lime was not applied. (See page 10.)



Effect of Potash on Yields of Hay

Disappearance of alfalfa where potash was not applied, while a good stand remained on the area receiving potash, apparently accounts for the wide difference in yield. (See page 15.)





Cortland apples showing internal cork due to deficiency of boron. The condition of these apples does not improve during storage. (See page 87.)



Excessive dropping of McIntosh just before harvest. Development of the use of "hormone" sprays may be a feasible approach to the solution of this problem. (See page 89.)



Typical Plants of the new Trellis Tomato No. 22, recently introduced to the Market Gardeners.  
(See page 80.)



Ideal Plant of Summer Pascal Celery  
(See page 80.)



The New Poultry Breeding House at Massachusetts Agricultural Experiment Station

The new poultry breeding house, which replaces the one blown down in the hurricane, is 18 feet deep and 126 feet long. There are twenty-four pens, each 5 feet by 14 and capable of taking care of nineteen females and a male, or a total of 480 birds for the house. The house is so arranged that two or four units can be run together. A room 6 feet by 14 at one end of the house allows some temporary storage of feed, eggs, and equipment and contains the control of the water supply. A 4-foot-wide service alley runs the length of the house, making it practically impossible for adjoining matings to become mixed. A solid board partition separates the alley from the pens. Each pen contains a wall feed hopper, a droppings pit, and six nests which allows about one nest for each three females. There are joint watering receptacles and drains for each two pens.

The house is insulated mostly with composition board although shavings have been used at the base of all walls under the windows, except in front. Cement floors and foundations and a galvanized rat shield twelve inches high should make the house reasonably rat-proof.

Each pen has a single standard sash for light and ventilation, and there is a 6-inch by 10-foot slot ventilator at the eaves in front for each two pens. This slot is easily controlled by means of an inexpensive adjuster.



**Control of Cabbage Maggot.** (W. D. Whitcomb, Waltham.) Eggs of the cabbage maggot were first found at Waltham on May 10, which is within the average period for the past eighty years. Infestation was slightly greater than normal as indicated by 87 percent commercial damage to untreated cabbage. In spite of favorable growing conditions during May and June, only about one-fourth of the untreated plants developed marketable heads.

Corrosive sublimate solution (1 ounce dissolved in 10 gallons of water) was again the most effective treatment. One application on May 13 gave 98.67 percent commercial protection and produced 87.25 percent marketable heads, while two applications on May 13 and 20 gave 99.33 percent commercial protection with 93.25 percent marketable heads. Root treatments with calomel-talc dusts containing 25 percent calomel or more gave at least 90 percent protection, but dusts containing 10 percent calomel permitted 17.57 percent commercial injury, and a 5 percent calomel dust allowed 38.93 percent moderate or severe infestation. However, plants receiving root treatment with 50 percent calomel or more produced only 57 to 70 percent marketable heads, indicating a delayed growth as well as protection from maggots. In comparison, the plants receiving 5 to 25 percent calomel dust on the roots produced 78 to 80 percent marketable heads in spite of relatively severe damage by maggots. A 50 percent calomel dust with a gypsum carrier gave definitely better maggot protection with a greater yield of marketable cabbage, in spite of apparently poor adhesion when applied, than did a 50 percent calomel-talc dust.

A comparison of the susceptibility of cruciferous vegetables to maggot injury shows the commercial injury as follows: Cauliflower 100 percent; collards 88 percent; cabbage 87 percent; kohlrabi and broccoli 84 percent; Chinese cabbage 64 percent; and Brussels sprouts 56 percent.

On radishes two dustings with 5 percent calomel-talc dust or sprayings with calomel-gum arabic suspension (1 ounce in  $2\frac{1}{2}$  gallons of water) applied 7 and 14 days after the seed was sown increased the average protection against maggots 11 percent in eight plantings from May 1 to July 10. In spite of this protection, 20 percent of the radishes were unmarketable and the treatment does not appear practical. Radishes grown from seed planted without treatment on May 29 and after July 10 had little or no damage from the maggot, while 30 to 60 percent of those planted May 1 to 20 and June 10 to 30 were infested.

**Control of Squash Vine Borer.** (W. D. Whitcomb, Waltham.) The field infestation by the squash vine borer in unsprayed Hubbard squash in the experimental planting at Waltham in 1939 was 3.24 borers per vine. This is about the average infestation during the last five years. However, favorable growing conditions produced the best yield of squash ever recorded and this yield was not greatly influenced by the borer infestation.

Insecticides were applied on July 6, 13, 20, and 27. Liquid sprays were much more effective than dusts. Nicotine sulfate 1-250 and nicotine sulfate 1-500 plus summer oil emulsion 1 percent reduced the number of borers per vine 74 and 77 percent respectively, while wettable derris spray (4 pounds in 100 gallons) with a resin sticker caused a 35 percent reduction. Derris-clay dust (.75 percent rotenone) failed to reduce the borer infestation, while a commercial copper-rotenone dust (.8 percent rotenone) and a commercial dust containing calcium arsenate, red copper oxide, flour, and talc permitted an increase of 27 and 33 percent in the number of borers per vine.

In spite of the borer infestation, the vines which received dust treatments yielded 10 pounds more marketable squash per vine than those receiving liquid sprays. The best yield (50.64 pounds per vine) was obtained from the vines receiving copper-rotenone dust, while vines receiving nicotine sulfate 1-250 as a spray yielded 35.08 pounds per vine. Increased yields in the dusted rows were

apparently due to the beneficial effects of a fungicide in two of the dusts, and to the fact that with favorable growing conditions the damage caused by an infestation averaging about three borers per vine in August does not materially reduce the yield of marketable squash.

**Control of Onion Thrips.** (A. I. Bourne.) Weather conditions in 1939 were not so favorable for the onion crop as in the previous year. The first part of the season was about 7 to 10 days later than normal. Seed onions were late in appearing and made slow progress during the early summer. Thrips were correspondingly late in making their appearance even on set onions and increased but little throughout June and early July. The drought which persisted from late June until the closing days of July, coupled with the high temperature and frequent hot, drying winds, combined to cause onions, as well as most other field crops, to suffer severely. Unfortunately these conditions were also ideal for the rapid development of thrips, so that by the third week of July the insects were increasing rapidly, and by the end of the month there was one of the heaviest infestations of recent years.

In the experimental plots in early July the plants were only 6 to 8 inches high and showed an average infestation of only 5 to 6 thrips per plant. A 7-day period of extremely hot weather from July 4 to 10 stimulated the development of thrips and more than doubled the infestation. The initial infestation was, however, so low that this increase was not serious although the drought was slowing down the growth of the plants. From July 24 to 29, however, there occurred a second period of abnormally high temperature, and development of thrips reacted quickly to bring the infestation to the peak of its abundance in late July and early August when the plots showed an average infestation of 132 to 134 thrips per plant. This heavy infestation and the continued drought, which persisted with only slight relief until the heavy rain of August 4, caused serious injury to the crop and led to premature death of the plants.

Studies of insecticidal control included field tests of the following sprays: pyrethrum-oil, rotenone-oil, nicotine-oil, derris alone and with talc or cherokee clay as adhesives, a pyrethrum-sulfur mixture, and the standard nicotine sulfate-soap combination. Dust applications were made with pyrethrum-sulfur and with calcium cyanamid.

All sprays containing nicotine or rotenone gave good to excellent control and were noticeably superior to pyrethrum combinations. The effectiveness of derris was somewhat improved by the addition of talc or clay. Derris also showed a marked residual effect which retarded reinfestation. Calcium cyanamid applied as a light dust to plants and soil caused a great reduction in the population of thrips but unfortunately killed the plants. When this material was used in an amount that was nontoxic to the plants, it failed to kill thrips. The nicotine sulfate-soap combination was again superior to all other sprays or dusts used, giving 95 percent effective control, and appears to be the most effective spray for this particular species.

**The Spray Residue Problem.** (A. I. Bourne.) The drought of midsummer which was not compensated for by the early autumn rains made the spray residue problem a serious one in most orchards, and only by employing a dust schedule or by a strict adherence to the recommended spray schedule with its progressively lighter dosage of lead arsenate in the late sprays was trouble avoided. Increasing abundance of codling moth and apple maggot in late summer made the problem more difficult, in spite of the new limits of tolerance announced in 1938. Records taken at the college showed that the deficiency in precipitation for the months of July, August, and September up to the time the McIntosh crop was harvested was nearly  $3\frac{1}{2}$  inches, and from the date of the first cover spray in early June the

total precipitation was only slightly greater than the amount of rain in the single storm which preceded the hurricane of September 1938. During the 4-month period there were only 7 records of precipitation of  $\frac{1}{2}$  inch or over and most of the rain occurred in light, brief showers which would have little effect upon spray deposits.

The present tendency on the part of commercial growers to replace lime-sulfur with wettable sulfurs led to a study of the effect of such a practice upon the residue problem. Analyses of the residue on fruit sprayed with wettable sulfur showed less than one-half as much lead and less than one-third as much arsenic as was found on fruit sprayed with lime-sulfur. The visible residue persisting on fruit which received some of the wettable sulfurs was evidently misleading, and the margin of safety represented by the difference in the persistence of spray deposit, particularly in a dry season such as 1939, strongly favors the movement toward wettable sulfurs.

Studies of supplementary measures to reinforce the spray schedule and of non-toxic insecticides for codling moth control were continued in the same orchard as in 1938. In addition to banding, a commercial fixed nicotine compound was used in the McIntosh block in late summer sprays to supplement the lead arsenate applications recommended in the regular schedule. Considerably better control of injury by late-season codling moth was secured with the fixed nicotine compound than with the regular spray schedule, shown both in percentages of clean fruit and in percentages of fruit showing late season "stings." The improvement due to the addition of the fixed nicotine compound was even more marked in the drops than in the hand-picked fruit.

The very great reduction in codling moth population was also reflected in band records in this orchard. The total number of larvae collected from 119 trees was 411, or an average of 3.4 per band; in contrast with 1,691 larvae collected from 103 trees in 1937 and 1,184 larvae collected from 93 trees in 1938.

**Apple Maggot Control.** (A. I. Bourne and W. D. Whitcomb.) The pest was somewhat more abundant than in 1938 and damage was much more prevalent than in 1937. Even the most careful growers throughout the State experienced difficulty in the proper timing of their sprays, and their crop showed more damage than usual. The protracted drought during the period of adult emergence interrupted and delayed the appearance of the flies in some orchards. In more favored locations, emergence was practically normal and the recommended schedule of sprays or dusts gave satisfactory control.

The record of emergence of apple maggot flies from the cages at Waltham is as follows:

	In Sun — Light Soil	
	Cultivated	Sod
1st fly.....	June 26	July 4
25% emergence.....	July 7	July 11
50% emergence.....	July 15	July 14
75% emergence.....	July 20	July 19
Last fly.....	Aug. 7	Aug. 1

**Insecticides for the Control of European Corn Borer.** (A. I. Bourne.) Weather conditions during May were very nearly normal, and on the whole were favorable for the development of both corn and the corn borer. The last frost occurred on May 16, the daily temperature was comparatively high, and from the 20th to the end of the month the minimum temperatures with but few exceptions were 50° F. or above. During that period there was only one storm of any consequence, so that pupation and moth emergence took place normally and there was little or no interference with egg deposition. The month of June was also very



nearly normal in both temperature and rainfall. There were light rains well distributed through the month and only three showers of more than one-half inch precipitation. Corn made rapid growth throughout the month, and there was little or no interruption of the spray program.

By the first week of June, egg masses were plentiful and examination of corn-fields at the college and vicinity indicated that larvae were beginning to appear on approximately June 8.

Studies of insecticidal control were conducted in cooperation with a commercial market gardener in Hampshire County. The field tests were made in his earliest planting of sweet corn, approximately one-half acre of Golden Early Market. Sprays were applied five times at 5-day intervals from June 8 to 29, to furnish protection throughout the period of larval appearance. An extra application was made to part of the field, at the owner's request, to insure protection against any late-appearing larvae.

The materials tested were derris and cube of 4 percent rotenone content; derris combined with Fluxit or with cherokee clay as adhesives; two commercial sprays, one containing 4 percent rotenone, and the second 2½ percent rotenone. Dual-fixed nicotine and two commercial rotenone dusts were also included in the tests.

The corn was harvested in three pickings from July 19 to 25. The infestation in the unsprayed plots was heavy. Only 23 percent of the ears in the first picking were borer free. The sprays, however, gave excellent protection. The cube and derris plots yielded 81 and 84 percent borer-free ears respectively, and 72 percent of the total yield was marketable. The addition of adhesive agents did not improve derris as measured in terms of clean ears but both materials allowed practically the same percentage of marketable ears as in the plots where derris alone was applied. The commercial 4 percent rotenone spray allowed 72 percent clean ears, and 63 percent of the total yield was of marketable grades. In the plots sprayed with 2.5 percent rotenone, 65 percent of the ears was borer free, and 52.4 percent of the yield was marketable. The total yield in the unsprayed checks was 40 percent borer-free, but only 32 percent of the crop was salable.

Good commercial control was secured in the dust plots. Dual-fixed nicotine allowed 77 percent borer-free ears while the two plots given commercial rotenone dusts showed yields of 71 and 76 percent clean corn. The adjacent check plots on the other hand showed only 40 percent borer-free ears, and only 33 percent of the crop was of salable quality.

The grower was able to salvage a larger proportion of the crop from the treated plots than is indicated above since the market was rather lenient regarding size and development of the ears provided they were free from borers, so that the amount of corn actually marketed by the grower very closely approximated the percentage of clean ears. This was not true of the corn in the unsprayed checks, however, since most of the infested corn contained large, well-matured larvae which had so damaged the ears that they were unfit for market.

**Potato Spraying Experiments.** (A. I. Bourne.) The subnormal rainfall which persisted throughout the entire growing season retarded the development of potato plants in all sections of the State; was reflected in the relative abundance and activity of insect pests; and, except in low areas, caused somewhat reduced yields. This deficiency in rainfall was accompanied by temperatures considerably higher than normal and by frequent hot, drying winds which rendered the plants very susceptible to spray injury.

Flea beetles were abundant throughout the season, particularly the second brood in late July and early August. Leafhoppers were late in appearing and at no time were abundant. A heavy infestation of potato aphids had developed by early August, but the addition of nicotine sulfate in the sprays of August 9



greatly reduced their numbers and a similar spray on the 15th practically eliminated them.

The experimental plots received 12 applications from June 13 to September 6. There was no evidence of blight, and except in the plots burned by commercial sprays the plants remained green until the crop was dug on October 9 and 10. The first frost occurred October 15, the latest date for this event in the college records. Weekly counts of flea beetle injury showed that there was less damage from flea beetles on plots which had received a 5-2½-50 bordeaux mixture than on those given the standard 5-5-50 strength. The addition of calcium arsenate somewhat reduced the injury in the low-calcium bordeaux plots but gave little or no added benefit in the plots receiving standard-strength bordeaux. In a season of very light and infrequent rains the extra deposit of lime on the foliage was apparently not so essential as in a year of more normal precipitation with frequent, heavy, driving rains. There was, however, greater tendency to burn from the 5-2½-50 bordeaux and this was reflected in the yield records.

Tests of commercial materials were confined to two new materials which were being placed on the market for the first time in 1939: Arasco, a micronized copper-arsenate mixture; and Cuproside, a newly developed yellow copper oxide spray. Talc and cherokee clay were used as adhesive agents with Cuproside. Plants sprayed with the yellow copper oxide began to show spray burn by the middle of July, and the damage increased steadily until most of the plants were dead by mid-August.

None of the commercial materials furnished as persistent coverage as bordeaux mixture, or as good protection against damage by flea beetle. Since most of the plants in the yellow copper oxide plots were dead by the end of August, little or no increase in growth of tubers could be expected beyond that point.

The yield from these plots, in view of the abbreviated growing season, would indicate that up to the time the plants died the tubers had made very satisfactory growth, as compared to the rest of the plots, and that, with further improvements by the manufacturers to render yellow copper oxide safer to foliage, the material should prove a valuable spray for potatoes.

**Introduction of Parasites of Oriental Fruit Moth in Peach Orchards.** (A. I. Bourne.) At the request of the peach growers, the work of rearing and distributing larvae of *Macrocentrus ancyliivorus*, parasites of the oriental fruit moth, was continued in 1939. As in the previous year, through the cooperation of the Department of Entomology of the Connecticut Agricultural Experiment Station, Mr. A. DeCaprio directed the collection of breeding material in New Jersey, breeding of the parasites, and delivery to the growers. The breeding work was conducted in the entomological laboratories at the college, and approximately 13,000 *Macrocentrus ancyliivorus* were liberated in the orchards of more than 50 growers in 8 counties of the State. *Macrocentrus* parasites in New Jersey were unusually scarce so that it was difficult to secure sufficient breeding material to fill the quota for Massachusetts growers. Our supply, however, was supplemented by material secured through the kindness of Professor Philip Garman of the Connecticut Agricultural Experiment Station, and was just sufficient to fill the orders received.

Weather conditions during the time the parasites were being liberated were favorable for their establishment in the orchards. Because of the dry weather which prevailed throughout late spring and early summer, growth of peach twigs was so much slower than normal that larvae of the oriental fruit moth failed to find the usual amount of succulent, tender twig growth and began in many orchards to enter the young peaches soon after they were formed. When the parasites were liberated, therefore, many of the oriental fruit moth larvae were

already inside the fruit and more or less inaccessible. Growers in near-by states where similar weather conditions prevailed had practically the same experience.

Preliminary tests of insecticides for the protection of peaches from late-season infestation were undertaken and some of the fixed nicotine compounds gave promising results.

**Naphthalene and Similar Compounds as Greenhouse Fumigants.** (W. D. Whitcomb and William Garland, Waltham.) Continued experimental fumigations with chlorinated naphthalene compounds showed that mixtures of chlornaphthalene oil 3 parts and crystal naphthalene 1 part, or chlornaphthalene oil 3 parts and chlornaphthalene soft wax 1 part, were noticeably more effective against red spider on carnation than a mixture containing equal parts of chlornaphthalene oil, crystal naphthalene, and paradichlorobenzene.

The use of these materials, at the rate of  $\frac{1}{2}$  ounce per 1000 cubic feet for 6 hours on potted carnations in an experimental fumigation chamber equipped with temperature and humidity control, showed that a temperature of 70° F. with a relative humidity of 60 percent was more effective against red spider than temperatures of 60° F. or 75° F. In twenty fumigations under these conditions the two most effective formulas produced an average kill of red spiders of 98.5 and 99.5 percent in two successive fumigations, with several fumigations causing complete mortality. No injury to potted carnations was observed from any of these experimental fumigations.

**Control of the Common Red Spider on Greenhouse Plants.** (W. D. Whitcomb, William Garland, and W. E. Tomlinson, Jr., Waltham.) In previous experiments and in commercial greenhouses the common red spider has been more difficult to control on roses than on other greenhouse plants. Observations during November and December under normal greenhouse conditions showed that the average period of development of the common red spider from the hatching of the larva to the adult female was 11.7 days on Talisman rose, 13.8 days on gardenia, and 15.0 days on snapdragon. Similar studies at controlled constant temperatures indicated that at 60° F., 70° F., and 80° F. the spiders required 14.25, 7.71 and 4.77 days respectively on rose, and 18.8, 8.80 and 6.75 days respectively on gardenia. On carnation and snapdragon the development was intermediate to the short period on rose and the long period on gardenia, but there were indications that under some conditions a longer period is required on snapdragon than on gardenia. The development of spiders on ten varieties of roses showed no significant differences when the greatest range was from 6.85 days on Souvenir to 8.0 days on Templar. On Talisman rose, spiders laid an average of 3.49 eggs per female, while on gardenias under identical conditions only 1.2 eggs per female were laid.

In spraying experiments conducted on bench roses under normal greenhouse conditions, derris or cube powder containing 4 percent rotenone, emulsified with sulfonated castor oil 1-300 and diluted at the rate of 2 and 3 pounds in 100 gallons, gave only moderate control of red spider in three applications at weekly intervals but good control after four applications. Derris was slightly more effective than cube but there was no significant difference between 2 pounds and 3 pounds in 100 gallons of spray. Control of red spider was significantly better on Talisman than on Templar, Premiere Supreme, or White Killarney. This spray left a slight residue but caused no plant injury.

In a second series, a dinitro compound prepared experimentally by Dow Chemical Company gave nearly perfect control on all varieties with no serious plant injury. Cyclonox, a phenol preparation, gave good control when used in the first application at 1-400 dilution but was only half as effective after a 1-600 dilution had been used in the three later applications. Plant injury was not

serious. R. S. 380, a combination of Lethane and rotenone by Rohm and Haas, diluted 1-400, gave good control of red spider but caused considerable foliage injury at one of the applications. Stantex dispersing oil with rotenone and soap, diluted 1-400, caused severe foliage injury after two applications and its use was discontinued.

In a third series of experimental sprayings, Dow's dinitro compound continued to give excellent control of red spider but caused slight foliage injury. Cyclonox, diluted 1-400 in each of the four applications, was very effective. Some plant injury resulted but none of it was severe or serious. R. S. 380 continued to give good control and was otherwise satisfactory. Bonox, a rotenone material from the Bonide Chemical Company, was not effective when diluted 1-400, and caused slight to moderate plant injury.

A fourth series of experiments showed that Dow's dinitro compound No. 2 with a different spreader continued to cause a high mortality of red spider but produced a moderate amount of injury in the form of marginal leaf burn. A peanut oil-nicotine mixture 1-200 and a peanut oil-rotenone mixture 1-400 both gave moderate kill of red spider but deposited an excessive oil residue on the leaves and caused some defoliation. A Serrid rotenone spray 1-200 was safe on plants but the mortality to red spider was low. Throughout this experiment, the mortality of red spider was greater on the Talisman variety and least on White Killarney.

**Biology and Control of the Apple Leaf Curling Midge.** (W. D. Whitcomb, Waltham.) The apple leaf curling midge, *Dasyneura mali* Kieff., was normally abundant in 1939 and is not known to have spread greatly from the previously known infested area. A new infestation was recorded in Shirley, Massachusetts, but apparently this had been present for two years.

Semi-weekly examinations from May 26 to October 4 showed that 49.93 percent of the available bud tips were infested with midge eggs. The emergence of flies and deposition of eggs was concentrated at three distinct periods, which indicate the beginning of each generation of the insect: June 1 to 9 with a second peak on June 20; July 7 to 18; and August 15 to 25. During the first infestation period most of the new growth on a tree was infested but after June 20 the infestation was confined to water sprouts which provided the only new growth available.

The time at which midge maggots left the rolled leaves to spin cocoons was considerably influenced by rainfall and was definitely concentrated in three distinct periods. Of the 11,743 maggots collected in bands and cages, 27.51 percent were taken on June 23 and 48.6 percent on August 1. Although only 302 maggots, representing 2.57 percent of the total, were collected on September 5, this was a much larger number than was obtained at any other time after August 8.

Under laboratory conditions no flies emerged in 1939 from maggots collected in June and July 1938 and held over winter, although about 50 percent had failed to transform in 1938. However, 35 to 71 percent of the maggots collected in August 1938 transformed to flies in 1939 after being held over winter under the same conditions as the maggots collected in June and July. In 1939, 68 percent of the maggots collected in June transformed; 52 percent of those collected in July; 21 percent of the August collection; and none of those collected in September.

Soil treatments applied just before the emergence period of the flies indicated that naphthalene flakes were an effective material for this purpose. Broadcast application of these flakes, at the rate of 2 pounds per 100 square feet, was the most effective treatment used and gave complete control in the experiment against the second generation flies. An application of naphthalene flakes at the rate of 1 pound per 100 square feet followed by cultivation was nearly as effective and gave better control than the same amount of naphthalene without cultivation.



Cultivation alone reduced the number of flies 71 percent and 99 percent in first and second generation experiments respectively, and appears to be worth while when insecticides are not applied. Calcium cyanide dust (1 pound per 100 square feet) and carbon disulfide emulsion (1 pint per square foot) were relatively ineffective.

**Control of Plum Curculio in Apples.** (W. D. Whitcomb, Waltham.) The plum curculio attacked apples at two distinct periods in 1939 and generally caused more damage to fruit than it has for several seasons. In many orchards this insect was the most destructive apple pest of the year. The first critical period occurred on May 31 and June 1, or about three days after the calyx application. At this time, the curculio caused the greatest damage to varieties such as Gravenstein, Astrachan, and Yellow Transparent, which grow rapidly immediately after blossoming. The second critical period continued from June 7 to 14 but was less destructive because adequate protection had been applied.

During the first critical period sprays using lead arsenate 4 pounds, wettable sulfur 4 pounds, and soybean flour 1 pound in each 100 gallons were applied to certain trees June 1, 3, and 6. Just before each application, 50 apples of each variety were measured with calipers to determine the average diameter in sixteenths of an inch.

On McIntosh and Wealthy the examination of about 70,000 apples, including drops, indicated that the spray applied on June 3 when the apples were approximately 4/16-inch in diameter was more timely and effective than the spray on June 1 when the apples were smaller, or on June 6 when they were larger.

**Biology and Control of the Grape Plume Moth and Grape Cane Girdler.** (W. D. Whitcomb and W. E. Tomlinson, Jr., Waltham.) The Grape Plume Moth, *Oxyptilus periscelidactylus* Fitch, was abundant throughout eastern Massachusetts, especially Metropolitan Boston, in 1939. Examinations of vines in home vineyards near Waltham showed that 32 to 78 percent of the buds were infested.

Laboratory studies proved that this insect has one generation annually. The eggs, which have not been reported in literature heretofore, are laid singly, embedded in the pubescence at a clotch or node on old canes. They are laid in late June and early July, and the average number laid by a female moth in captivity was 12.6. Incubation is completed in about four weeks, but the larva remains in the eggshell until the following spring. The larva hatches about May 10 and feeds for about one month. The pupal period averaged 11.6 days and moths emerged during late June and early July, living seven to twelve days in captivity. The photographs on page 50 show some of the stages of the insect, as well as typical injury to vines.

Dormant sprays applied both in the laboratory and in home vineyards killed the eggs without injury to the vines, and these records are the first known reports of effective control of the grape plume moth with insecticides. The most effective treatments were spraying with sodium dinitro cresylate diluted to 1 and 1½ percent and with oil emulsion (mayonnaise type) diluted to 3 percent. These sprays applied April 21, which was about two weeks before the larvae hatched, reduced the number of infested tips from 55 percent to 2 and 5 percent in one experiment, and from 77 percent to 7 and 19 percent in another experiment.

The results of these studies have been submitted for publication in the *Journal of Economic Entomology*.

The Grape Cane Girdler, *Ampelogypter ater*, Lec., continued to increase in eastern Massachusetts in 1939 and on some of the infested vines 75 percent of the new canes were girdled.

Life history studies in the insectary showed that there was one generation annually and that the insect hibernates as the adult. Early in June when the



grape canes reach 6 to 8 inches in length the beetles begin to lay eggs and continue for about a month. The egg is usually laid in a small cavity eaten in the stem just above a ring of holes which girdle the cane and cause it to break. The girdle cut, which is made by twelve or more punctures in a ring around the stem, apparently serves to eliminate or reduce the pressure of the growing cane so that the larva can hatch and feed more easily.

The life cycle was completed in about 51 days, being divided into 11.6 days for incubation of the egg, 26.8 days for feeding of the larva, and 12.4 days for pupation. The beetles, which emerge early in August, feed slightly on the veins on the under side of the leaf before going into hibernation. In 171 girdled canes examined between June 19 and August 10, 40 percent of the egg punctures were empty or contained dead eggs. Spraying potted grape vines with lead arsenate and calcium arsenate greatly reduced injury by the beetle but did not prevent the canes from being girdled.

#### **Liberation of Parasites of the European Earwig.** (W. D. Whitcomb, Waltham.)

The European earwig is now established in southern Bristol County, especially in the vicinity of Fall River, Taunton, and New Bedford, where it is a serious annoyance to housekeepers and a minor pest of plants.

In June and July, 1939, 1,000 adult flies of the earwig parasite, *Bigonichaeta setipennis*, were sent in four shipments to Boston by Air Express from the Pupalup, Washington, laboratory of the United States Bureau of Entomology and Plant Quarantine, and were liberated in the infested area. In spite of the long trip by airplane 90.6 percent of these parasitic flies were alive and healthy when released.

Previous to the liberation of the parasites, about forty earwig traps or hiding blocks had been placed at strategic points in the infested area and examined frequently to determine the presence of a suitable number of earwigs for effective parasite establishment. As a result of the trap examinations, parasites were liberated at eleven locations as follows: Fall River 4, Dighton and North Dighton 3, Somerset 2, and Segreganset and Assonet 1 each.

Examinations of the earwig traps for the presence of puparia of the parasitic fly were made on August 16, September 14, October 10, and November 14, 1939. On August 16, 2 puparia of the parasitic fly were found at a liberation point on North Street, Somerset. No other parasites were recovered in any traps at any of the examinations.

Traps will be returned next year to the points where parasites were released, for it is reported that, if the parasites become established, they are more likely to be recovered during the following season than immediately after the flies are released.

#### **Insects Concerned in the Dispersal of Dutch Elm Disease.** (W. B. Becker.)

An article entitled "Larval development of the native elm bark beetle, *Hylurgopinus rufipes* (Eich.), in Massachusetts" was published in the *Journal of Economic Entomology* 32 (No. 1):112-121, 1939 (Contribution 309).

Mr. W. E. Tomlinson of the Waltham Field Station again cooperated by continuing experiments on the biology of the native elm bark beetle and the smaller European elm bark beetle, in Waltham. The following records were taken.

*The Native Elm Bark Beetle, Hylurgopinus rufipes* (Eich.). Adults reared from eggs laid in American elm logs in late April and early May of 1938 began to emerge in early August of the same year. No beetles of this brood emerged from these logs during 1939. Since 1934 when the beetle was first studied at Amherst, and during the time it has been studied at Waltham, no adults of the early spring brood have been observed to emerge after the late fall of the same year, although

an occasional live larva and young adult of this brood have been found in the logs during the winter.

In logs from trees felled by the hurricane of September 21, 1938, eggs were laid early in June 1939. The adults began to emerge on July 29 and emergence was still being observed on October 18, 1939.

*The Smaller European Elm Bark Beetle, Scolytus multistriatus Marsham.* The adults reared from eggs laid in elm logs in May 1938 started to emerge in early August of the same season, but many larvae passed the winter in the logs and emerged as adults in June 1939. It is possible that adults that emerged after early August 1939 belonged to the same brood, but it seems likely that they resulted from a later attack on the same logs.

Logs cut in midsummer of 1938 were infested with *S. multistriatus* which passed the winter in the immature stages, the adults emerging during the 1939 season.

In logs from trees felled by the hurricane, eggs were being laid in early June 1939. The adults began to emerge on July 20 and emergence was still being observed on September 10, 1939.

In addition to the biology studies at Waltham, scouting work was carried on in western Massachusetts for *S. multistriatus*. All towns adjacent to those already known to be infested were visited, but the only findings new to this office occurred in two locations in the town of Sheffield where adult beetles were found.

**The Effects of Solar Heat on the Subcortical Development of the Native Elm Bark Beetle, *Hylurgopinus rufipes* (Eich.), at Amherst. (W. B. Becker.)** Since it was noticed that *Hylurgopinus rufipes* apparently did not breed successfully in the upper side of small logs of American elm, *Ulmus americana* L., which were in direct sunlight, it was decided to try to get more definite data on this subject.

Elm logs infested with *H. rufipes*, from trees felled during the hurricane of September 21, 1938, were used in the experiment. On July 12 and August 5, 18, and 21, 1939, logs were cut into two equal sections; one section was placed in a large open field where it could receive direct sunlight from sunrise until near sunset, and the other was placed under a tree in the shade of the foliage. All logs were laid directly on the ground, in a north-south direction, and the grass around the logs in the sun was kept short to prevent any possible shading. The logs were put out about 8:30 a. m. and were removed about the same time of day, after different periods of exposure. The beetle mortality in the upper half of the logs in the sun was recorded and checked with the development in the lower half and in the shaded logs.

In the upper half of those logs in the sun, 100 percent mortality occurred in all except one log. This log had relatively thick bark ( $\frac{1}{4}$  to  $\frac{5}{16}$  inch thick) and had been exposed for only 1 day (8:30 a. m. on August 18 to 8:30 a. m. on August 19). Even in this log, however, only 2 larvae, 1 pupa, and 2 adults were alive, all of them being on the east side of the log only slightly above the line dividing the upper half of the log from the lower half. This is where the sun first strikes the logs in the morning when the temperature of the adjacent environment is cooler than later in the day.

In each case when logs were examined during the subcortical life of *H. rufipes*, specimens were found alive in the under side of the logs in the sun and in any side they happened to infest in the check logs in partial shade. Later such shaded bark also showed the presence of emergence holes, which bore witness to the fact that beetles had completed their development and departed.

In the upper half of the logs in the sun, the larvae killed in 12 or more days beginning July 12 were severely desiccated, indicating that they were killed in less time than that. The degree of desiccation appeared to vary more or less with the length of exposure.

## FEED CONTROL SERVICE

Philip H. Smith in Charge

The Feed Control Service comprises not only feed inspection, but several other activities, as listed below:

Feed Control (General Laws, 1920 Chapter 94)

Seed Control (General Laws, 1927 Chapter 94)

Dairy Law (General Laws, 1920 Chapter 94)

Miscellaneous Work

**Feed Control.** (P. H. Smith, A. F. Spelman, J. W. Kuzmeski, L. V. Crowley, F. A. McLaughlin, J. T. Howard.) During the fiscal year 1,981 samples of feeding stuffs were officially collected and examined in the control laboratories. The gross receipts from the registration of feeding stuffs in 1939 were \$24,760, derived from 1,238 brands at \$20 each.

**Dairy Law.** (P. H. Smith, J. T. Howard, G. E. Taylor.) During the year ending December 1, 1939, 6,328 pieces of Babcock glassware were tested; 108 certificates of proficiency were awarded; and 235 creameries, milk depots, and milk inspectors' laboratories were visited in order to check methods and pass upon equipment in use. As a result of this inspection, four machines were condemned.

**Miscellaneous Work.** (P. H. Smith, A. F. Spelman, J. W. Kuzmeski.) Numerous analyses have been made for residents of the State and other departments of the college.

*Summary of Miscellaneous Work, 1939*

Milk and cream.....	727
Ice cream.....	92
Feeds, from farmers and dealers.....	87
Feeds, from State Institutions.....	795
Feeds and forage crops, from Experiment Station.....	132

## FERTILIZER CONTROL SERVICE

H. D. Haskins in Charge

**Fertilizer Inspection.** (H. D. Haskins, H. R. DeRose, J. W. Kuzmeski, A. F. Spelman, L. V. Crowley, Chemists; J. T. Howard, C. L. Whiting, L. A. Graves, Sampling Agents; G. E. Taylor, Laboratory Assistant.) Records for the year show that 126 firms have registered for sale in the State of Massachusetts 538 brands of mixed fertilizer and fertilizing materials and 52 brands of agricultural lime and gypsum. Results of analysis show that 50 percent of the mixed fertilizer brands, 69 percent of the unmixed fertilizer brands and 85 percent of the lime brands showed no deficiencies. The gross receipts from the registration of the fertilizer and lime products and from fertilizer tonnage fees for the year 1939 were \$15,386.76.

For about ten weeks, beginning April 1, three experienced men employed to draw samples for inspection purposes sampled 23,602 sacks or containers, representing 23,020 tons of materials; 173 towns were visited, and 1,818 samples representing 519 brands were drawn from stock found in the possession of 415 agents or owners. The following summary shows the character of these substances, as well as statistics with reference to their inspection.

	Brands Registered	Brands Collected	Samples Drawn	Number of Analyses	Number of Determinations
Mixed fertilizers.....	340	350	1,100	457	8,143
Ground bone, tankage and fish....	44	42	143	45	580
Nitrogen products, mineral and or- ganic.....	50	48	227	124	536
Phosphoric acid products.....	34	35	145	38	549
Potash products.....	16	15	72	23	147
Dried pulverized natural manures..	29	29	88	29	292
Nitrate of potash.....	6	7	11	7	48
Peat products.....	3	3	6	3	27
Wood and cotton hull ashes.....	8	7	11	11	83
Miscellaneous.....	10	10	24	11	122
Lime products.....	53	52	117	59	1,061
Totals.....	593	598	1,944	807	11,588

During the period July 1, 1938, to July 1, 1939, the tonnage of fertilizer and plant food sold in Massachusetts was as follows:

	Fertilizer (Tons)	Plant Food Elements (Tons)		
		Nitrogen	Available Phosphoric Acid	Potash
Mixed fertilizers.....	41,616	2,131	3,529	3,053
Unmixed fertilizer chemicals and materials.....	20,800*	1,324	1,974**	775
Pulverized natural manures.....	1,558	33	28	43
Totals.....	63,974	3,488	5,531	3,871

\*Not counting 1,779 tons of triple superphosphate distributed through A. A. A.

\*\*Not including 825 tons of available phosphoric acid distributed through A. A. A.

Full details of the fertilizer and lime inspection will be found in Control Bulletins 100 and 101.

**Miscellaneous Analytical and Diagnostic Work.** (H. D. Haskins, H. R. DeRose, A. F. Spelman, J. W. Kuzmeski, L. V. Crowley.) Chemical studies have been carried on in cooperation with several departments of the Experiment Station, Field Station, County Agents, and men in charge of the Soil Conservation work of the State. The character and extent of this work is shown in the following summary:

Apple spray residue.....	32	Peat.....	4
Cranberry spray residue.....	5	Poultry manure.....	15
Fertilizer mixtures.....	21	Soil.....	44
Forage and field crops.....	224	Triple superphosphate (A. A. A. distribution).....	39
Grain ration.....	1		
Insecticide.....	1		
Limestone (A. A. A. distribution).....	22	Total.....	408

Other work of the department has included consultations on various projects where chemical problems were involved.

Mr. H. R. DeRose has made some vegetation pot studies during the winter and early spring on buckwheat and tomatoes, to note the effect of some of the trace elements on plant growth. The chemical analysis of the crops has not been fully completed.

A considerable variety of chemical work has, as usual, been done for other State Institutions, community organizations, firms and individuals having problems of agricultural interest. This group includes the analyses of the following materials:



Animal tissues for mineral poisons.....	4	Miscellaneous.....	8
Fertilizer chemicals.....	10	Peat products.....	11
Industrial by-products.....	6	Poultry manure.....	6
Lime products.....	6	Soils.....	3
Lime-sulfur.....	1	Wood ashes.....	2
Mixed fertilizers.....	27*		
		Total.....	84

\*Includes 15 private mixtures officially sampled.

## DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

**Breeding Snapdragons for Varietal Improvement and Disease Resistance.** (Harold E. White, Waltham.) Field tests for rust reaction and selection of the most promising Field Station strains are being continued. The yellow-flowered lines set seed more readily and abundantly than the white- or pink-flowered strains, and for this reason it has been possible to make a greater number of individual selections of yellow forms. The pink-flowered strains, in addition to being slow growing, are difficult types to true up as to exact shades of color. Pure white flowers, even after continued selection, have a tendency to show a touch of yellow in the palate of the flower. The stem length in most of the strains is satisfactory but further improvement is needed in the size of the individual florets and the length of flower spike. No indication of inherited resistance to the wilt disease has been observed in commercial varieties or in the Field Station strains.

**Effect of Plant Nutrients, Soil Reaction, and Light on Gardenias.** (Harold E. White, Waltham.) Gardenia plants fed with the same fertilizer mixtures from year to year have varied in their response to such treatments, the number of flowers produced and buds dropped varying according to the fertilizer treatment and seasonal conditions.

Over a period of three years less bud drop was noted with organic materials than with fertilizers carrying ammonium or nitrate salts. Seasonal conditions, however, appeared to have a greater bearing in determining the degree of loss than did the fertilizer treatment. Flower production seemed to be influenced by the same factors which determine bud drop. Gardenia plants did not appear to grow any better in cinders than in soil.

Species of Gardenia plants, grown from seeds obtained from South Africa, seem to be less sensitive than commercial varieties to soil conditions which cause symptoms of iron chlorosis. The species on which observations have been made are: *rothmannia*, *globosa*, *thunbergia*, *jovis-tonantis* and *radicans*. The varieties Belmont, Hadley, Mystery, Veitchi and the species *florida* show susceptibility to iron deficiency.

**Forcing Tests of Hybrid Easter Lily Seedlings.** (Harold E. White, Waltham.) One hundred bulbs of hybrid lily seedlings grown in Charleston, South Carolina, were received from the United States Horticultural Station at Beltsville, Maryland, for greenhouse forcing tests. The performance of the majority of the seedlings, as regards time required for forcing, number of blooms produced per plant, size and texture of blooms, was comparable with results one might expect to get from bulbs imported from Japan. The results of these tests with American-grown seedling lily bulbs would indicate that the production of such bulbs for greenhouse forcing may become a new horticultural enterprise in this country.

**Cultural Requirements of Freesias.** (Harold E. White, Waltham.) The practice of drying Freesia corms for a certain period prior to planting, which is considered essential for successful forcing, results in a definite loss in weight dependent on the length of the curing period. The loss in weight varied between 1 and 2 percent for curing periods of 2 to 3 weeks, but after the fourth week increased rapidly. The greatest loss in weight was 31 percent, which was for a curing period of 13 weeks. The loss in weight of corms cured in a potting shed at a temperature of 70° to 75° F. was comparable to that of corms cured at a controlled temperature of 60° to 65° F. Corms cured for 1 to 3 weeks did not appear to make any more rapid vegetative growth than uncured corms. Data on the relation of the length of the curing period to time and degree of flowering are not yet available.

Modification of the growing media by the addition of manure or sand had no noticeable effect on the rate of vegetative growth.

**Physiological Disorders of Carnations.** (Harold E. White, Waltham.) The sticking and growing together of petals of carnations, a condition commonly known as adhesion, and brought about by some physiological condition of the plant, has been observed to occur sporadically in greenhouses during the past six years. In a number of instances where this physiological disturbance has been encountered, it has seemed to be associated with particular brands of fertilizers applied to the soil. The chief difference between brands of fertilizer that appeared to cause adhesion and brands that did not, seemed to be the high nitrogen content of the mixtures which, under unfavorable light or other growing conditions, were associated with the trouble.

Through the interest and cooperation of a well-known fertilizer manufacturer certain features of a particular fertilizer formula were checked to determine whether any of the materials in the mixture might possibly be the cause of adhesion. Changes made in the original formula were modifications in the ratio of nitrate, ammonia, and organic nitrogen and in the sources of potash. Five different fertilizer combinations were used in the tests. No adhesion was observed with any of the fertilizer mixtures used.

This test does not definitely prove that the fertilizers used may not have been associated with the cause of adhesions, but would rather indicate that there are other factors, such as cultural or seasonal conditions, concerned with this peculiar physiological disorder.

One other trouble with carnations has been observed this past year, in which the nodes or joints of the flower stems were greatly enlarged, causing the stems to grow in a zigzag manner and resulting in a breaking over at the nodes where the swelling occurred. This disorder has so far been confined to certain varieties. It has been suggested that fumigation with naphthalene might be a cause, but this is not definitely known. In all probability this trouble may also be associated with certain nutritional disorders.

**Packet Seed Studies.** (Clark L. Thayer.) For a fourth season the Department of Floriculture has cooperated with the Seed Laboratory in a test to determine the quality of flower seeds sold in retail seed stores, garages, hardware stores, groceries, schools, and other retail outlets. The seeds, which were collected by the State Seed Inspector, were weighed and analyzed for purity in the laboratory and were tested for germination and performance under field conditions.

The test included 224 lots, representing 42 genera, packeted by 30 wholesale establishments. Records on germination in the field showed 150 lots, good; 38 lots, fair; 31 lots, poor; 5 lots, no germination. Records on performance in the field showed 168 lots, satisfactory; 56 lots, not satisfactory. Detailed results are included in Control Series Bulletin 102.

## DEPARTMENT OF HOME ECONOMICS NUTRITION

Helen S. Mitchell in Charge

**Cause and Control of Nutritional Cataract.** (H. S. Mitchell, G. M. Cook, O. A. Merriam, and A. W. Wertz; Graduate Assistants: Gertrude J. Hadro, Mary D. Henderson.) The study of the biochemistry of cataract continues to be the major project in this department. While the experimental cataract produced by feeding galactose to rats may not be exactly like certain types of human cataract, it is sufficiently similar to justify further study of factors which may hasten or delay its development. In the course of this study unexpected metabolic interrelationships have appeared and where possible these also have been studied in an effort to better understand the influence of other dietary factors upon carbohydrate metabolism. The results of all this animal research may ultimately suggest some clinical applications. This method of producing experimental cataract in rats in a few weeks was discovered in 1935 and has since then served as a unique approach to the study of a little-understood pathologic phenomenon.

1. *The Effect of Nitrogenous Factors on the Cataractogenic Action of Galactose.* Since it has been established by earlier work in this laboratory that a protein deficiency aggravates cataract development, and that a liberal supply delays it, the question naturally arises as to what factor in protein is responsible for this protective action. The relatively minor differences noted between proteins from widely varied sources, mentioned in the last Annual Report, gave almost no clue to the nature of the factor responsible for the inhibition of lenticular change. The observations with cystine previously reported were followed by a limited number of experiments with methionine. Neither of these sulfur-containing amino acids fed as supplements to a 15 percent protein ration afforded protection against cataract commensurate with protection given by adding protein yielding an equivalent amount of these amino acids. The negative results obtained with massive doses of thiamin chloride, riboflavin, yeast, and ascorbic acid, as well as the excellent condition of the animals, offer convincing evidence that no known vitamin deficiency is concerned. Nitrogenous products such as urea and choline have been fed as supplements to the galactose ration with essentially negative results. Work now in progress is concerned with the feeding of proteins treated in various ways which are known to alter the nutritive value of protein for growth. Thus the problem is still unsolved as to why and how protein or some fraction thereof can function to inhibit lenticular changes in rats in the presence of a high blood galactose.

2. *The Effect of Calcium Salts on the Utilization of Lactose.* Considerable variation has been observed in this laboratory in the effect of different calcium salts on the digestion and absorption of lactose. Rats were fed an adequate ration containing 60 percent lactose, plus 1.0 or 0.5 percent of calcium added in the form of six different calcium salts: respectively, tricalcium phosphate, carbonate, citrate, lactate, levulinate, and gluconate. Rats on any of the first five calcium salts showed as good growth as those on the plain 60 percent lactose ration, less diarrhea in general, about the same degree of galactemia, and a similar incidence of cataract. With calcium gluconate fed at the 1.0 percent calcium level, few rats survived; these grew but little, had severe diarrhea, low blood sugar, and no lenticular changes. With 0.5 percent calcium as the gluconate, survival was better, growth poor, diarrhea moderate, lenticular changes few if any. These criteria all indicate that calcium gluconate prevents most of the lactose from leaving the intestinal tract. Since calcium gluconate shows no inhibitory effect upon the absorption of the single sugars, glucose or galactose, the problem must



concern the digestion of lactose. Sodium gluconate, fed at corresponding levels, exerted a similar, but rather more severe, deleterious effect. It would seem that the gluconate radical in some way inhibits lactase activity. The phenomenon known as "competitive inhibition of enzyme action" is postulated as a possible explanation for this finding. A paper on this subject was published in *Journal of Nutrition* 18:319, 1939 (Contribution 347.)

A continuation of this work using both alpha- and beta-lactose fed at a somewhat lower level, 45 instead of 60 percent, confirmed the above findings in general and gave no evidence of any difference in the two forms of lactose.

3. *The Influence of Different Salt Mixtures on the Utilization of Lactose.* Preliminary evidence indicates that the amount and type of mineral elements in a ration may influence the rate of breakdown and absorption of lactose. Two commonly used salt mixtures seem to have slightly different effects. Experiments now in progress are designed to study the effect of the type and amount of salt mixture on the growth, blood sugar, diarrhea, and lenticular changes of rats fed a 60 percent lactose ration.

**The Comparative Effects of Kelp, Kelp-ash, and a Synthetic Salt Mixture on Cholesterol-induced Atherosclerosis in Rabbits.** (H. S. Mitchell and G. J. Hadro.) A review of the literature shows a growing interest during the last few years in the etiology and therapy of atherosclerosis. A disease similar to that in humans may be induced in rabbits by feeding cholesterol. By this device factors which inhibit this pathologic change may be studied. Since a certain degree of protective action by kelp was shown in previous experiments, it seemed desirable to continue the investigation in an effort to ascertain, if possible, the active principle in the kelp.

In the preliminary experiment one litter confirmed the protective action of the kelp while the other three were less positive in results. The observed correlation between the amount of cholesterol eaten and the degree of lesions necessitated more careful control of cholesterol feeding in subsequent experiments. Another experiment was performed in which kelp, kelp-ash, and a synthetic salt mixture prepared to resemble as nearly as possible the inorganic constituents of kelp were fed to compare the effects of the whole kelp and inorganic constituents of the kelp. About two-thirds of the iodine of the kelp was lost upon ashing. The iodine content of the salt mixture was planned to correlate with that of the kelp.

The salt mixture tended to inhibit hypercholesteremia and protect against aortic lesions as well as the dry kelp and significantly better than the kelp-ash. This indication that no organic factor in kelp is responsible for its beneficial action and previous negative results with potassium iodide alone raise the question as to whether some combination of inorganic elements including iodine is responsible for protection of rabbits against cholesterol-induced atherosclerosis.

**The Adaptometer as an Instrument for Detecting Vitamin A Deficiency.** (H. S. Mitchell, O. A. Merriam, and E. Miller.) It is generally accepted that vitamin A is necessary for the synthesis of visual purple in the retina. Bright light bleaches visual purple, which is resynthesized when a person adjusts himself to dull light. The rate of adjustment is supposed to correlate with the amount of vitamin A available up to a point of physiological optimum which has not as yet been established. The Adaptometer was designed by J. B. Feldman for making rapid dark adaptation tests on large numbers of persons in order to detect those showing a marked deficiency in this respect. The American Optical Company, who are manufacturing the instrument, provided a research grant to this department for a survey of faculty and students on the campus, and for a study of the limits of accuracy and usefulness of the instrument.



Several technical adjustments were necessary before the survey could be undertaken. Lack of uniformity in instruments was a major problem. The addition of a chin rest, a white visor, and voltage-control were improvements necessary to satisfactory use of the instrument.

The survey of students, faculty, and some other interested persons covered 248 subjects ranging from 5 to 65 years. Of the 163 college students tested only 3 percent gave readings above the normal range (1-5 minutes); of the 75 adults, 18 percent were abnormally high. The self-selection of the adult group, dictated by a personal interest or recognized pathology, may have brought the subnormal average for this group higher than would have been true for a fairer cross-section of society.

The color of eyes was recorded for each subject tested and the data studied to discover whether this factor appeared to have any significance. The percentage falling outside the normal range was slightly higher for the "light eye" group than for the "dark eye" group. The peak for both groups fell at about 1.75 minutes, however, and a relatively small group of stragglers accounted for the subnormal averages.

Seventeen subjects whose time of adaptation was more than five minutes formed a group for further study. Each subject agreed to take three haliver oil capsules daily for 15 days and return for another reading on the adaptometer. Five of the subjects failed to improve, six showed less than one minute improvement and six improved from one to three minutes. The time for more extensive study of these subnormal subjects was limited by the end of the school year.

## DEPARTMENT OF HORTICULTURAL MANUFACTURES

### W. W. Chenoweth in Charge

**Cranberry Research.** (C. R. Fellers, A. S. Levine, F. Yourga, and J. Lubitz.) Experimental work has been conducted on several new cranberry by-products such as juice, syrup, relish, and wine. By destroying the natural pectin in raw-pressed cranberry juice by means of the enzyme preparation, Pectinol, the juice may be concentrated and sweetened as much as desired without pectin precipitation. Cranberry relish prepared from sliced cranberries and sugar together with apple or orange can be held for several months in glass jars without heat treatment. Sherry wine and dilute alcohol solutions serve to preserve and flavor the relish for longer periods.

Cooperative research with the Cranberry Station and the Department of Engineering on storage conditions has been continued. Gas analysis of cranberries stored under varying conditions shows that breakdown occurred much more slowly at temperatures below 45° F. than at 55°. There are two types of breakdown or softening: physiological and phytopathological. Both were greatly accelerated by raising the storage temperature. Another aspect of storage work has shown that "floats" from the bogs can be materially improved in keeping quality by prompt drying at low temperatures. Such berries may now be used for shipping as fresh fruit as well as being utilized in manufactured cranberry products.

Some work has been carried out in preparing a "syrup of cranberry" for use as vehicle in compounding drugs and medicines. A very satisfactory syrup was made by cold-pressing the berries and sweetening the juice. Excessive pectin is obtained when the berries are heat extracted. This syrup served as an excellent carrier and masking agent for chloral hydrate, potassium acetate, ammonium chloride, and many other substances.

The tenderizing action of cranberries on meats and fowl has been investigated. Apparently no proteolytic enzymes similar to papain are present. The tenderizing action seems due entirely to the acids present.

An analysis of the pulp or press residue resulting from juice manufacture shows the following percentage composition: moisture 64.0, solids 36.0, ash .30, total acidity 0.23 (as citric acid), pectin 2.9, pH 2.8, together with traces of vitamins A and C. This residue comprises approximately 20 percent of the original weight of the fruit, and is worth saving for use in cranberry sauce manufacture.

A study seeking to ascertain the effect of cranberries on calcium ingestion was completed and the results published in *American Journal of Digestive Diseases* 6 (No. 2):116-119, 1939 (Contribution 321).

**Apple Products.** (C. R. Fellers and J. A. Clague.) Two products have been studied, canned baked or glazed apples and canned apple slices in syrup. The former study was reported in a paper entitled "Canned Baked Apples," in *Canning Age* 20 (No. 2):68-70, 82 and (No. 4):179-181, 1939 (Contribution 327).

Canned sliced apples in syrup, to be used largely as a dessert fruit, have been prepared in many ways. Best varieties are Baldwin, Winesap, Russet, Northern Spy, Rhode Island Greening, and Spitzenburg. A 40° syrup of either sucrose alone or a mixture of 60 percent sucrose and 40 percent dextrose, gave the most favored degree of sweetness. The cooked slices must be treated under vacuum in order to remove tissue gases and make the slices appear clear and transparent. This product is easily prepared and very acceptable as a fruit dessert. It is not on the market at the present time.

**Vitamin D Studies.** (C. R. Fellers, C. F. Dunker, and L. R. Parkinson.) Rat bioassays on approximately 162 samples of vitamin D milk produced and sold in New England during the year showed only one sample seriously deficient, and four slightly deficient in content of vitamin D. Irradiated, fortified, and metabolized types of vitamin D milk were examined.

A series of 18 samples of cod liver oil sold for use in poultry rations was bioassayed by the A. O. A. C. chick method. The oils sold in Massachusetts conformed remarkably well to their stated vitamin D guarantees.

As associate referee of the A. O. A. C. committee on Vitamin D Assays, C. R. Fellers has conducted several cooperative tests with rats and chicks in an effort to standardize the vitamin D assay. One result of this cooperative research has been to reduce the period of assay from 10 to 8 days to reduce the number of feedings of Reference Oil from 5 to 3.

In studies on scurvy in guinea pigs, it was found that massive doses of vitamin D in scorbutic guinea pigs did not delay the development of symptoms nor did vitamin D aid in maintaining a normal bone-ash content in these animals.

**Antiseptic Action of Acetic Acid.** (A. S. Levine.) Investigations have been conducted to determine the effect and action of acetic acid (vinegar) on various food spoilage microorganisms including bacteria, yeasts, and molds. Increasing the hydrogen-ion concentration by the addition of acetic acid lowered the thermal death points of the bacteria studied. Growth of the bacteria was inhibited in nutrient broth adjusted with acetic acid to pH 4.9; the yeast *Saccharomyces cerevisiae* (Lister) did not grow at pH 3.9 in dextrose broth with an acetic acid content of 0.59 percent; and growth of the mold, *Aspergillus niger*, was inhibited at pH 4.1 in broth containing 0.27 percent acetic acid. The addition of 5 percent salt or 20 percent sucrose altered but little the toxic effect of acetic acid to bacteria and yeasts. *Aspergillus niger* grown in flasks seemed to utilize the sugar to produce a more luxurious mold growth during the incubation period. The final acidity of the solution was greater than the initial acidity, thus showing a conversion of the sugar into organic acids. Comparison studies showed that

acetic acid was more toxic than either lactic or hydrochloric acid to *Salmonella aertrycke*, *Saccharomyces cerevisiae*, and *Aspergillus niger*. These organisms were inhibited in growth or destroyed at a higher pH value when acetic acid was used as the toxic agent than when lactic or hydrochloric acid was used. The mold utilized relatively high amounts of lactic acid to develop a luxurious growth heavier than that obtained from the acetic acid or the hydrochloric acid series. The toxicity of acetic acid to various microorganisms is not due to the hydrogen-ion concentration alone, but seems to be a function of the undissociated acetic acid molecule also.

**Nutritional Studies on Spinach.** (C. R. Fellers and C. F. Dunker.) These studies were reported in a paper entitled "Vitamin C Content of Spinach," published in the *Proceedings of the American Society for Horticultural Science* 36 (1938):500-504, 1939 (Contribution 339).

**Factors Influencing Nutritive Value of Snap Beans.** (C. R. Fellers and K. T. Farrell.) The vitamin B<sub>1</sub> content of snap beans was 3.5 I. U. per gram, on a moisture-free basis. Freezing apparently had little effect on this vitamin unless the blanching process was omitted, when there was a 40 percent loss. Snap beans canned in glass or tin suffered a 20 percent loss. While frozen blanched beans lost very little vitamin B<sub>1</sub> in 12 months' storage, the canned products showed a 40 percent decrease.

Freezing and canning had little effect on the vitamin B<sub>2</sub> content of snap beans. The average value was 7 Bourquin-Sherman units per gram.

Vitamin C in the fresh snap beans averaged 2.8 I. U. per gram, on a moisture-free basis. A 32 percent loss occurred during freezing, whereas canning resulted in a 75 percent loss. There was no significant loss in the canned or frozen product after 12 months' storage at 45° F.

If the juice from the cans is discarded, 20 to 50 percent of the water-soluble vitamins go with it. The type of container, i. e., glass or tin, showed no marked effect in any of the assays.

**Fruit, Vegetable, and Other By-Products.** (C. R. Fellers, K. G. Shea, and Wm. B. Esselen.) In order to determine the possible feed value of dried tomato pomace, a waste product from the manufacture of juice and pulp, chemical and biological analyses were made. A report of the work was published in *Poultry Science* 18:45-47, 1939 (Contribution 310).

A study of dried corn distillers grains and concentrated slop was also reported in *Poultry Science* 18:89-95, 1939 (Contribution 311).

Active work now under way indicates that cocoa shell meal is approximately one-third as valuable as cod liver oil as a source of vitamin D for rats. The riboflavin content is also appreciable. It seems possible that this waste product of the cocoa industry may become a useful component of poultry rations.

**Food Value of Potatoes.** (C. R. Fellers and Mary E. Lyons.) This investigation has been continued and the results published in *American Potato Journal* 16:169-179, 1939 (Contribution 346).

**Use of Corn Sugar in Foods.** (C. R. Fellers, A. S. Levine, and L. Tarkow.) Results are reported in a paper, "Dextrose in the Food Industries," published in *American Journal of Public Health* 29:135-138, 1939 (Contribution 322).

**Iron Availability Investigation.** (C. R. Fellers and W. H. Hastings.) The availability of iron in such foods as haddock, peas, asparagus, and broccoli is uninjured by commercial freezing methods. The effect of the canning process is variable, and work is under way to study further the availability of iron in canned foods.



**Glass Container Research.** (C. R. Fellers and K. R. Newman.) This study, sponsored by the Glass Container Association of America, has thus far been limited to a determination of head-space and dissolved gases, particularly oxygen, in bottled citrus, apple, and tomato juices. In general, oxygen disappears from bottled juices in 15 to 25 days at room temperatures. Ascorbic acid losses parallel the oxygen loss, indicating a direct oxidation of the former. Coincident with oxygen disappearance is the development of undesirable color and flavor changes in the beverage. The presence of large amounts of oxygen in the head space intensifies and accelerates flavor and color defects. Methods of oxygen removal at the time of filling the containers are now being studied.

## DEPARTMENT OF HORTICULTURE

R. A. Van Meter in Charge

**Powdery Mildew on Garden Phlox.** (Harold S. Tiffany, Waltham.) Preliminary tests were conducted for the control of powdery mildew (*Erysiphe cichoracearum*) on garden phlox (*Phlox paniculata*), from the standpoint of plant tolerance and residue as well as disease control. No plants were sprayed until an appreciable amount of the mildew was evident throughout the plantings. Materials for control were then applied at ten-day intervals up to the flowering period.

Hammond's Copper Solution (1-150) resulted in fairly complete control and left no residue on the plants. Bordeaux mixture (2-2-50) gave equally good control but left objectionable residue. Neither of the other materials tested gave satisfactory control.

**Propagation of Hybrid Lilacs.** (Harold S. Tiffany, Waltham.) Late taking of lilac cuttings has been widely believed to offer a very low percentage of rooting. Four hundred internodal lilac cuttings (*Syringa vulgaris*, varieties Souvenir de Ludwig Spaeth, Marceau, Congo, Charles the Tenth, Jan Van Tol) were taken on July first, a full month after the wood was in prime condition for taking. Forty cuttings of each variety were given a constant temperature of 75° F. by electric cable, and forty were kept at room temperature of the benches. Each forty cuttings of the same variety were further divided into tens, receiving (a) Hormodin powder No. 3; (b) Rootone; (c) Hormodin A (60 BTI units for 24 hours); (d) no treatment. Five of each ten cuttings were terminal, and five had terminals removed, to test the theory that terminal leaves transfer a higher percentage of growth substances to the base of the cuttings than do other leaves. The cuttings were all placed in a medium of one-third peat and two-thirds sand; cheesecloth tents were provided; and the cuttings were watered fairly heavily.

Varietal response to the various treatments was pronounced. While bottom heat at 75° F. definitely hastened rooting of some varieties this effect was not consistent with others. Treatment with a growth substance was effective with some varieties; others rooted better with no treatment. At the end of thirteen weeks, 53 percent of the cuttings had produced good and excellent root masses. The ratio of terminal cuttings rooted was one-third higher than of those without terminals. With the exception of six plants lost, the potted plants produced excellent root systems and strong winter buds. Further trials will be made in 1940.

**Factors Influencing the Rapidity of the Growth of Nursery Stock.** (Harold S. Tiffany, Waltham.) The fertilization of evergreens, in order to provide maximum quality growth, represents a problem on which comparatively little research has been done. In view of the importance of such material to ornamental plantings, investigations have been started by the establishment of fourteen plots



of Carolina Hemlock (*Tsuga caroliniana*), ten trees to the plot, which will receive different treatments in 1940.

**Factors Influencing the Hardiness of Evergreens.** (Harold S. Tiffany, Waltham.) Winter injury to evergreens is a serious problem both in nurseries and in ornamental plantings, particularly of those species which are injured at infrequent intervals only, and at such times to an extreme degree. Cultural treatment seems to be one of the factors involved. Accordingly three plots of the spreading English Yew, *Taxus baccata repandans*, have been started as suitable material for study, since the species *baccata* is outstanding in the list of plants affected. By 1940 the plants should be sufficiently established to allow the beginning of the treatments to be tested.

## DEPARTMENT OF OLERICULTURE

Grant B. Snyder in Charge

**Shape Index Studies of Tomatoes.** (W. H. Lachman.) It has been demonstrated in past years that shape indices are quite reliable in making quantitative comparisons among varieties of tomatoes. These studies have been continued with the idea of ascertaining the influence of season upon the form of fruit in several tomato varieties. Under unfavorable growing conditions the polar diameter of the fruit is greater in proportion to the equatorial diameter than under more desirable conditions.

**Sweet Corn Breeding.** (W. H. Lachman.) This project was initiated three years ago in an effort to isolate inbred strains of sweet corn which excelled in earliness, productivity, disease resistance, and quality. More than 1600 plants of eight early commercial varieties were self-pollinated and have since been carried in pedigreed lines. From this early work 300 lines have been selected as the best of the progenies.

The planting has been made on the same plot each year. The soil in this plot is evidently thoroughly contaminated with root, stalk, and ear-rot diseases of corn. In addition to this, each plant has been inoculated with the bacterial wilt disease. Approximately 200 of the lines show a moderate to high degree of resistance to all of these diseases. Most inbreds of Golden Gem, however, seem to be particularly susceptible.

Many of the lines showed a remarkable degree of uniformity the past year and will be combined in the hybrid condition to further test their usefulness.

**Hybrid Sweet Corn Trials.** (W. H. Lachman.) Thirty-five hybrid varieties of yellow sweet corn were planted for trial during the past season. Many of these performed very well but were a little too late in maturity for general usefulness in Massachusetts. Four of the varieties were especially noteworthy: Spancross C4.13, which was exceptionally early; Marcross C13.6, an early sort with an ear of good size; Marcross 13.39, a second early with an ear of good size and exceptional quality; and Golden Cross Bantam, a midseason variety with a large ear, high productivity, and excellent quality.

**Tomato Breeding.** (W. H. Lachman.) The primary object of this project is to incorporate the uniform ripening character into otherwise desirable commercial tomato varieties. Most commercial varieties of tomatoes have a green to yellow-red coloration of the shoulders when firm ripe. This character is undesirable from the market viewpoint.

By cross-pollinating a variety of little importance possessing the uniform ripening character with six commercial varieties of tomatoes, many promising segregates have been noted and selected for further study. Although the work has

progressed to only the third generation, several lines appeared to be quite uniform during the past growing season.

**Cultural Practices Prior to Field Setting as Influencing Yield and Quality of Peppers.** (W. H. Lachman.) This project was started last year in an effort to determine the effect that different methods of handling plants prior to field setting might have upon the earliness, yield, and quality of the fruits produced. The Waltham Beauty strain of pepper has been used throughout the test.

Plants grown in clay pots until time for field transplanting consistently out-yielded plants receiving all other treatments. Nutrient solutions at the rate of one pint per plant added at the time of field transplanting markedly increased both the early and total yield with all the basic treatments.

**Variety Studies.** (W. H. Lachman.) These studies were begun last year in cooperation with the Rhode Island and Connecticut Experiment Stations. The object of the work is to determine the influence of the various climatic and edaphic factors upon the general adaptability of several strains and varieties of snap beans, celery, cabbage, tomatoes, peppers, and sweet corn. It is planned to continue this project for five years, and as yet no general conclusions have been drawn.

**Asparagus Investigations.** (Robert E. Young, Waltham.)

*Varietal Improvement.* The most important information obtained from a study of the field records of 278 selected asparagus plants is that the high-yielding plants selected as parents for new strains have continued to remain high yielding throughout seven cutting seasons. A paper by G. C. Hanna of the California Agricultural Experiment Station indicates that asparagus plants may yield heavily the first few years only to become mediocre later. Only one of the parents of the five new strains of asparagus now under culture at Waltham has shown any tendency to fall off in yield.

In 1937, five rows of asparagus plants from the selected parents were planted. These plants produced a larger number of stalks during the first summer than in either of the two succeeding years. The number of stalks per plant was reduced considerably this past year, probably because of their being harvested and of the extremely dry season. While these plants were cut for only two weeks for the first harvest, the records give some indication of which rows are superior. Rows 1 and 4 have produced a large number of spears per plant. During the past three summers, they also produced the largest number of stalks per plant during the summer season. The rows that produced the largest number of spears per plant also had the highest yield in pounds per plant. All the rows of the new asparagus planting gave better yields than a commercial strain planted for comparison, the two best strains producing over twice as much.

Of the best twelve plants out of 450, selected on the basis of the number of spears produced, four were female and eight were male. When ranked on the basis of weight, nine were female and three were male. Most of these high-yielding plants were from the two highest-yielding strains.

*Depth of Planting and Height of Culling.* The yield of the depth-of-planting plots returned to normal this year after having been very low the previous season. There has been no change in the relationship of the yields; the plots where the roots were planted 2 inches deep gave the best yields, followed respectively by those planted 4 inches, 8 inches, and 6 inches. This rank is in direct relationship to the number of plants remaining in the plots except for those where the roots were planted 8 inches deep.

In October of 1939 the asparagus tops were removed and the land leveled. After a period during which the soil settled, the asparagus crowns were examined and their depth determined. Roots originally planted 2 inches deep were found

to vary from 2 to 7 inches, with an average depth of 3.6 inches. Roots originally planted 4 inches deep were found to vary as did those planted 2 inches, the average depth being 4.5 inches. The average depth of roots planted 6 and 8 inches deep was 3.9 and 4.5 inches respectively. While there are some differences in the average levels, it might be said that all the asparagus plants formed at the level they preferred for the soil in which they were planted, which is a Merrimac fine sandy loam underlaid with coarse gravel. The information concerning the levels to which asparagus crowns grow, together with yields and stand counts, is being prepared for presentation before the American Society for Horticultural Science.

The height-of-cutting records continue to show that when asparagus tips are cut the yield will be less than when spears are cut with 8 inches of green. Almost 35 percent more 4-inch spears per plant have been produced than 8-inch, but the yield in pounds is much less for the nine years the plots have been harvested. Cutting spears with 12 inches of green has not reduced the yield in pounds of asparagus although it reduces the number of spears.

It would seem from the results of this experiment that the best returns from an asparagus bed can be obtained by cutting the spears with 8 inches of green. However, there seems to be no danger of injuring the bed by producing long asparagus, even up to 12 inches.

It appears from the two sets of asparagus records that have been kept for seven and nine full cuttings seasons that the peak of production comes in the third year.

**Trellis Tomato Experiments.** (Robert E. Young and Paul W. Dempsey, Waltham; Alden P. Tuttle, Amherst.) This past season was a very dry one, and it is of interest to note that pruning tomatoes to a single stem increased the percentage of cracking of fruit. The plot that had potted plants pruned to a single stem produced the largest early yield and the greatest total yield. The plots that produced notably low yields were those without fertilizer, those with plants not trellised, and those without manure. The plants not pruned or trellised produced only one-third the early yield of the best trellised plot. These untrellised plants produced fruit that had the least cracking. Additional irrigation also greatly reduced cracking. The work on trellised tomatoes has been concluded.

**Vegetable Breeding for Improvement of Quality.** (Robert E. Young, Waltham.)

*Lettuce, New York Type.* (In cooperation with United States Department of Agriculture.) Approximately 10,000 plants were grown last season in the search for a better adapted lettuce. Of these plants, the four single-plant selections made from a new hybrid were outstanding for heading, color, and resistance to tipburn. These new types are hybrids similar to the Cosberg, which is a light yellow variety, except that they are dark green in color and produce a better head.

During the past season the aster yellows disease was quite severe and widespread, affecting lettuce all over the northeastern United States. In other seasons from 10 to 25 percent of the selected plants have become infected with aster yellows and have been lost, since the diseased plants do not produce seed. This past year approximately 85 percent of the selected plants became infected with the disease, thus causing a loss of the most important breeding stock. Whether the increase in the extent of the disease is due to weather, or is a natural increase which will persist in future years, remains to be determined. Certainly some method of protection must be found if a breeding program is to continue.

The selections that have been grown for a number of seasons continue to be superior to commercial varieties. However, they are susceptible to the same trouble as the commercial varieties but to a lesser degree.

*Greenhouse Lettuce.* The first generation of a cross between Bel-May and Cheshunt Giant was produced in the greenhouse. Although both of these varieties



of lettuce contain no pigment, all the hybrids had spots of red pigment on the leaves. This is an undesirable character. However, according to a study of the genetic behavior of pigments in lettuce by R. C. Thompson of the United States Department of Agriculture, this character will not remain in future generations. The second generation was produced in the fall of 1939 and only a small percentage was pigmented. In this cross between a light green lettuce and a dark one, the  $F_2$  generation produced 50 light green and 164 dark green plants. The other desirable characters were also redistributed in a desirable way that will enable the best plants to be selected in very few generations.

*Celery.* The growers who tried samples of Summer Pascal celery seed distributed last year gave most favorable comments and the celery met with almost state-wide favor. The most impressive demonstration of the desirability of a product that has high quality is the fact that during a season of unusually low prices Summer Pascal celery sold for at least twice the price of yellow celery. One grower reported selling three hundred dollars worth of celery from the teaspoonful of seed sent out as a sample. Seed of this variety has been made available commercially and will be grown extensively next year. It is a celery that under some conditions is more difficult to grow, but the high quality justifies the extra care. Summer Pascal celery seed was obtained from a grower in another section of the country who had kept it within the family for over forty years. It is not a perfected strain and many single-plant selections have been made in an attempt to purify it. Experiments attempting to force the plants to seed in the greenhouse during the winter in time for next year's crop have failed. This work is being continued and plants have also been sent to the Federal Experimental Station in Puerto Rico in an attempt to speed up the seeding of these plants.

Variety trials with over thirty varieties of green celery were made for the second year. The results of this work indicate that most of the varieties will not bleach with sufficient ease for local conditions. Many of the varieties have stalks so rough as to be unmarketable on the Boston market.

*Tomatoes.* Waltham Forcing and Field Station No. 22 have become widely used as trellis tomatoes. The Early Trellis which was distributed last year proved to be too small to be of value. It is of great interest to note that most of the Massachusetts growers who had both Waltham Forcing and No. 22 reported that the latter produced larger fruit. Growers in the section around Lowell, however, reported the reverse to be true. At the Field Station it required 4.6 fruits to make one pound of the Waltham Forcing tomatoes, and 3.6 fruits of the No. 22.

For the past few years selection work has been under way to improve the internal quality of the Waltham Forcing. After this year's crop, it was concluded that the particular undesirable characteristics could not be eliminated by selection. A new program of hybridization will be undertaken to improve the quality of these tomatoes. The hybrid material that has been made in the past and has been under trial will be kept.

A comparison of Waltham Forcing and No. 22 with other strains of Comet in the variety trials indicates that their most outstanding characteristics are heavy setting of fruit, a large percentage of No. 1 fruit, and an outer cell wall that is resistant to bruising and keeps the tomato in a firm condition long after many varieties have become unsalable.

Waltham Forcing, which was originally developed for use in the greenhouse, maintains its popularity.

*Rutabaga or Cape Turnips.* Two years' trials of all the available varieties and strains of Rutabagas, both white and yellow fleshed, which could be obtained

in this country and abroad have shown that if a perfected strain is to be developed it must come from material already locally adapted. Strains grown locally, though reported faulty, are better than those obtainable elsewhere. The results with single-plant selections indicate that large numbers must be used if the breeding program is to go forward. A large number of selections is now in storage, and with the varieties no longer in the plantings more space and time can be devoted to breeding work.

The yellow sport from a strain of White Cape mentioned in last year's report has been further tested and found to be a very desirable type, having the same characteristics as the White Cape except the flesh color. Crisp flesh free from fiber and with not too much turnip flavor is what makes the strain desirable.

*Cucurbita Pepo.* The work with this crop has been completed with the development of a uniform strain in plant type, shape of fruit, and condition of seed.

*Hutchinson Carrot.* The work with this crop is conducted in two ways. The most important part is the maintenance of the strain and replenishing the supply of stock seed. Through rigid selection of the stock seed roots, a gradual improvement in the color of the carrots has been noted by growers. Particular attention has been given to internal color. The old Hutchinson had a large yellow core. The Field Station strain now has a medium-sized core of quite good color.

The second phase of the work with carrots is the hybridization of Hutchinson with other carrots of better internal quality. A carrot obtained from the Bureau of Foreign Plant Introduction of the United States Department of Agriculture has been used as one parent in these crosses. Methods have been developed that will permit the production of carrot seed from selected roots in the greenhouse in time for planting the next year, thus making an annual out of the biennial carrot. The F<sub>2</sub> generation of these better quality hybrids was grown this year and a large number of very good selections has been made.

*Waltham Beauty Pepper.* The work of developing a better adapted pepper has been continued this year with thirty selections from hybrids in which one parent was Waltham Beauty. These hybrids are now in the third and fourth generation. Very few plants have been found that contain the desirable characteristics of the Waltham Beauty without poor ones. The amount of cross-pollination in peppers in this section has not been determined. No bags have been used to prevent cross-pollination. This year the selected plants were moved to the greenhouse where a new crop of fruit is being produced under conditions that make cross-pollination impossible. A comparison will be made of the self-pollinated seed with that raised in the field.

*Green Sprouting Broccoli.* At the request of many growers, over 40 varieties and strains of green sprouting broccoli were collected this past year, from this country and abroad. These were grown in the hope of finding a more uniform strain of this vegetable that is becoming more popular each year. No strain was found to be particularly better than another. There is a variation of over a month between the harvest of the early plants and that of the late ones in the same strain. Selected plants have been saved and are being seeded in the greenhouse for planting next year in hope of obtaining a strain more uniform in maturity and type of head.

*Wyman Crosby Beet.* This strain of beet that has been developed from the strain of one of the local growers will be sent out to selected growers for trial on their farms. If it proves to be superior, it will be increased for future use. It has been found that to obtain much improvement in the internal color of beets it is necessary to use single-plant selections instead of mass selection. Several plants have been seeded in the greenhouse and were planted this last year in the field. Further selection has been made from these for next year's trials.

*Horticultural Shell Beans.* Work with shell beans is being concluded with this year's work. A good strain of shell bean has been developed and is being used by many farmers. Wider use of the bean has been prevented by a lack of commercial supply of seed. One association has tried six times to have a crop grown for them with failure in all cases. Seed for distribution to farmers who wish to get a stock of the bean will be maintained.

*Greenhouse Cucumbers.* Some time has been devoted during the last year to the gathering of strains of greenhouse cucumbers prior to starting breeding work. All the strains were planted outside and were self-pollinated to purify them. Further purifying must be done before hybridization can be accomplished.

## DEPARTMENT OF POMOLOGY

R. A. Van Meter in Charge

The effects of the hurricane of September 21, 1938, on our orchards were not as injurious as was feared by some. The trees, not too badly torn up or broken, were set up and held by guy wires and very few of them have, thus far, shown injury. The crop produced was the heaviest since 1930. It remains to be seen whether the root damage followed by a heavy crop will weaken the trees in future years. Apple trees bloomed heavily and the fruit set well. Rainfall was somewhat deficient during the season but there was enough in late summer and early fall to favor good size of the apples.

Fruits other than the apple were fair to good except raspberries. The canes suffered severely from winterkilling. Peach buds survived the winter and trees that were healthy bore good crops. The severe cold in late November was unprecedented. No colder weather was experienced through the winter. This early winter cold may have been the cause of injury to raspberry canes and nursery apple trees.

**The Influence of Various Clonal Rootstocks on Apple Varieties.** (J. K. Shaw and L. Southwick.) The stock bed yielded a fair crop of rooted layers which were lined out for budding. They made a fair growth in spite of the rather dry season. It has been observed that any variety grows about equally well on all stocks the first year. This may be because the root system of a very dwarfing stock is enough to promote good growth of the single bud. In the second and third year dwarfing effects may be seen with some varieties and stocks, but in many cases vigorous growth continues until the tree begins to bear at an early age for the variety. Growth in height is retarded before growth in spread, giving a rather low-headed tree. The type of the root system is largely controlled by the rootstock, but its size is determined by the variety budded on it.

Preparations have been made to set another stock bed next spring to replace the present one, which is not as productive of rooted layers as it should be.

Some additions were made to the cooperative orchards and all have been visited and measurements taken. Many made very little growth, probably owing to the dry season. These were the ones in sod. It becomes increasingly evident that it is very difficult to grow a young orchard in sod. Either cultivation or an adequate mulch is essential.

Starking on Malling XIII and XVI, set at the Waltham Field Station on a rich, moist, loamy soil in 1936, blossomed and bore heavily. Other varieties in the same orchard blossomed lightly or not at all.

The new orchard mentioned last year was set in the spring of 1939. It includes 900 trees of many varieties, old and new, on the various clonal stocks. The tree



locations are randomized according to the latest ideas of such plantings. It is laid out so as to permit some cultural or fertilizer test which will be started after a period of uniform treatment to give more light on soil variations. A smaller orchard of 55 trees was also set to replace one ruined by the hurricane.

The clonal stock orchard set in 1937 grew well irrespective of the rootstock, and some trees, mostly on the dwarfing stocks, bore a few apples. It promises to produce more next year, the fourth year of growth.

The older clonal stock orchard set in 1928 produced a large crop. The trees, McIntosh and Wealthy set 20 x 20, after eleven seasons' growth, are becoming crowded and showing signs of inadequate nutrition. Three reports of results from this orchard are included in the scientific contributions from this Station.

**Tree Characters of Fruit Varieties.** (J. K. Shaw, A. P. French, O. C. Roberts, and L. Southwick.) Practically the same nurseries as in recent years were visited and trees examined for trueness to name. A slightly greater number of apple trees was certified than in 1938.

The stand of cherry buds in the nursery was again poor but at least a few buds of most varieties grew and afforded an opportunity to learn their distinguishing characteristics. The stocks on which the buds failed were cut back and shoots allowed to grow up to four per plant and these budded usually to two buds each. With this excess of inserted buds, it is hoped to get a satisfactory stand of all varieties and collect data and photographs for a publication on cherry varieties. It is believed that all these varieties that are really distinct can be identified as nursery trees.

The peach nursery of some 60 varieties grew well and afforded opportunity to collect a considerable amount of data. Most varieties can be identified with considerable certainty, but there are a few groups of varieties which are so nearly alike as to make certain identification of individual varieties impossible. The varieties have been budded on additional stocks for further study next year.

Further observations of pear and plum varieties have indicated that there are certain varieties of these fruits that require careful study, so a small nursery of such varieties is planned for next year.

**The Genetic Composition of Peaches.** (J. S. Bailey and A. P. French.) In the spring of 1939 some crossing and selfing was done. Although they had been recorded as free from X-disease in 1938, five of the nine trees used developed X-disease before the summer was over. It is probable that the pits from these diseased trees will not germinate.

A campaign was started to eliminate all chokecherries from around the Station and College orchards. Various concentrations of a chlorate weed killer were used to find out how the work can be most effectively and cheaply done.

In the fall of 1939 peach seedling block S<sup>2</sup>, M, N, and the budded seedlings were removed since they were no longer needed for record purposes. The men of the Experiment Station service developed a very rapid and effective method for pushing the trees out of the ground and shaking the dirt from the roots by chaining them to the bulldozer attachment of a caterpillar type tractor.

Calculations on a second population of selfed Belle seedlings agree with previous results in that they show linkage in the coupling phase between the free-cling and the melting-nonmelting genes.

**Comparison of Cultivation and Sod in a Bearing Orchard.** (J. K. Shaw.) The changes in fertilizer treatment made last year were continued in 1939. The orchard bore a crop of nearly 1400 bushels or approximately 20 bushels per tree, which was by far the largest thus far produced. The attempt to harrow in the mulch applied last year to plot 3 was not very successful because the soil was

very compact and the mulch less decayed than expected. A second application of waste hay, about two tons per acre, was made, and the trees bore the most heavily of any in the orchard even though the trees, after 18 years of cultivation with no fertilizer, were the smallest of any. This astonishing increase in yield over previous years is probably not due entirely to the mulch, as all our McIntosh trees bore heavily this year, but it is believed that the yield was larger than it would have been if no mulch had been applied. This suggests that the use of mulching materials in amounts much smaller than were used in our other experiments may be a wise practice. For many reasons we confidently advise the use of mulching materials brought in from outside the orchard whenever they can be obtained at a reasonable cost.

**Comparison of Cultivation and Heavy Mulching for Apples.** (J. K. Shaw.) The McIntosh block in this experiment was removed in the spring of 1939 on account of severe damage from the hurricane which blew over in varying degrees 13 of the 18 trees. The area was at once replanted with trees largely Wagener and Rhode Island Greening on clonal stocks. No additional mulch was applied as it was felt that there was an ample amount already. The mulching will be continued as seems wise. The young trees behaved alike on both the mulched and cultivated plots, none making good growth perhaps because of injury to the pith and xylem from winter cold while the trees were in the nursery. The Wealthy block suffered little from the storm and is being continued as before.

**The Effects of Fertilizer Limitation on Fruit Plants.** (J. K. Shaw.) Some of the trees have been removed and the rest will be pulled out next spring because they are getting too large for the limited area. The fertilizer applications on this field—nitrogen, phosphorus, and potash, alone and in combination—have now been continued with few changes for 50 years. There are no differences in available phosphorus in the soil between the plots that have had continuous phosphate applications and those that have had none. The differences in available potash and nitrogen are not consistent.

**Effect of Potash and Lime on Apple Trees.** (J. K. Shaw.) The effort to invigorate the trees in this orchard by strip cultivation was continued and the fertilizer treatment remained the same. The trees seem to be responding and a heavy crop was produced. The nitrogen-fertilized trees continued to yield far better than those receiving only phosphorus and potash. The addition of potash to nitrogen seems to have slightly increased yields but the difference this year was insignificant.

**Study of Varieties of Fruits.** (J. K. Shaw and staff.)

*Apple.* Observations in the nurseries show that the so-called red bud sports of many varieties continue to replace the varieties from which they sprung. Probably this tendency means improvement, but in many cases the parent varieties, when well grown, may be quite as attractive as the new ones—but they are not always well grown. Occasional comments suggesting inferiority of the sporting variety in vigor, productiveness, and other characters are not yet supported by experimental evidence. This question will be investigated in another project at this Station. Some of the red sports of Gravenstein seem to keep better than Gravenstein. This may or may not be an advantage.

Cortland seems to be gaining in favor but cannot yet be said to be a major variety in this State. It seems to be more susceptible to internal cork than other varieties but it appears that this can be controlled. It is a favorite variety of the curculio. It is susceptible to storage scald, and must be picked at the proper stage of maturity. In our experiments this has been about two weeks after McIntosh. The variety has met with sales resistance in the market, but this is

being overcome by advertising and by its many good qualities. We would rather take a chance with Cortland than with McIntosh after Christmas. It is excellent for kitchen use, especially salads, as it does not turn brown. The tree is very satisfactory, hardy, mechanically strong, has a strong tendency to annual bearing, and it is a good pollinating variety. It should be regarded as a replacement of Baldwin rather than of McIntosh. Perhaps it should not be planted extensively, but we regard it as one of the most promising varieties to supplement McIntosh.

Kendall is still on trial, with little evidence of its value here. Its greenish flesh is the defect most often mentioned. It is said that this will be less evident if the apples are allowed to mature well on the tree. The apple is attractive in shape and color but the quality seems inferior to McIntosh and Cortland. We have as yet little evidence on the very important character of productiveness.

Early McIntosh meets with considerable approval from growers. It is attractive, of good quality for its season, and its name attracts customers. On the other hand, the tree habit is poor, it is strongly biennial, and the apples are apt to be small unless heavily thinned. There is room for something better for its season.

Milton is of the same season and a better variety in tree habit and in quality. Were it not for its peculiarity of bearing apples of unattractive shape, it should be preferred to Early McIntosh. Perhaps as trees get older the shape of the apple will improve.

A bud sport of Gravenstein from a Lunenburg orchard bore very attractive apples that may prove equal or superior to the strain now in cultivation.

An orchard of several hundred seedlings, grown from seeds obtained in cross-pollination experiments several years ago, fruited quite generally. Among them were several that were promising. More careful observations in later years may possibly reveal some trees that are worthy of propagation and further trial.

*Pear.* Gorham continues to prove desirable, being attractive and of good quality. It resembles Bartlett and is about two weeks later in season.

Phelps is also of the Bartlett type but later in season. It is of good size but unattractive in appearance and of inferior quality.

*Peach.* The New Jersey Station continues to breed many excellent new varieties. Some will prove desirable for Massachusetts, but some will be less successful here because of lack of bud hardiness. Golden Globe (N. J. 73) is a competitor of Halehaven, maturing about a week later than Golden Jubilee. It seems rather tender in tree and bud and not as good in quality as when grown in New Jersey. Goldeneast (N. J. 87) is another New Jersey variety which does not reach as high perfection here as in New Jersey, but it is a little more promising than Golden Globe. Fire glow (N. J. 71) is also better in New Jersey than here. It is so tender in bud that it is likely to be an uncertain cropper in Massachusetts. Eclipse competes with Goldeneast and Halehaven and it seems probable that this older introduction will lose out in the competition.

Halehaven replaces South Haven, an earlier production from Michigan, and all agree that it is an improvement. It ripens between Golden Jubilee and Elberta and is worth trying. Polly closely resembles Champion and therefore has no place except for strictly local trade. We have no evidence as to whether it is superior to Champion.

Some of the peach trees grown for variety study in the nursery will be used to establish a new variety peach orchard to be planted next spring. This should give us much additional first-hand information about varieties.

*Raspberry.* Marcy continues to perform well and has not yet shown mosaic infection. The berries are large, attractive and of good quality. It is a good



producer and superior to Taylor in quality. Our Taylor plants now show 100 percent mosaic infection; in Newburgh the percentage is much lower. No roguing has been done in these rows.

All Geneva introductions have been quite severely killed back the past two winters, while Latham and Chief have shown little or no such injury.

*Strawberry.* Pathfinder (N. J. 35) has proved to be attractive, of good shape, juicy, of fair quality and a good producer. North Star (U. S. D. A. 1425) is large, of attractive appearance, of high quality and satisfactory in productiveness.

**Fruit Bud Formation in the Strawberry.** (R. A. Van Meter.) Continuing a study of the relation of mulching to winter injury and the behavior of fruit buds, 30 plots of 180 plants each were established in the spring of 1938 and harvested in 1939. The thickness of the mulch had a direct bearing on the amount of winter injury but the time of mulch removal needs further study as it may affect the behavior of fruit buds as reflected in yield.

To complete this study 20 plots of 300 plants each were planted in the spring of 1939. These were given four treatments in five replications, as follows:

1. Light mulch to be removed early.
2. Light mulch to be removed late.
3. Heavy mulch to be removed early.
4. Heavy mulch to be removed late.

Observation of the effect of these treatments on yields next season should bring this phase of the study to an end.

**Bud Mutations.** (J. K. Shaw and W. H. Thies.) Among the many scions collected several years ago in the belief or hope that they were bud sports, is one that has possibilities. This is a highly colored Gravenstein that seems equal and may prove superior to the Red Gravenstein now grown. Most others have proved little or not at all better than the parent variety.

The collection of possible bud mutations of the McIntosh has been carried on and 20 different lots are now budded in the nursery. Not all of these are thought to be improvements on the variety as commonly grown, but most of them are of higher color as indicated by the fruit of the trees from which they came. These trees will be grown and fruited to see, not only whether they have superior color, but whether they are in other respects equal or superior to the variety as commonly grown.

It was observed that the buds of one strain started a little later and did not grow quite as tall as did those of three other strains. This observation requires confirmation before it can be said that the strain is really less vigorous than the others.

**Gas Storage of Strawberries and Apples.** (O. C. Roberts.) During the past season a study of the effect of CO<sub>2</sub> on the storage of strawberries, raspberries, and apples has been made. The work this year has been of a preliminary nature and has consisted chiefly in a study of technique and general observations. Conclusive results have not yet been attained.

**Study of Behavior in Storage of Apples Affected with Internal Cork.** (O. C. Roberts.) It is generally recognized that certain varieties of apples grown in soils deficient in boron will in dry seasons develop internal cork or corky core. Some growers have expressed the opinion that this condition may disappear to a greater or less extent in storage. In order to obtain exact data on this problem, samples of apples, known to be affected with internal cork, were collected from orchards in Middlesex County and brought to Amherst. On September 26 random samples were selected from these lots and examined for amount of internal cork present. The remaining apples were divided into two lots, one of which was

placed in common storage and the other in cold storage at 32° F. On November 26 samples from these two lots were examined, and the remaining apples left in storage for further examination in January 1940. Results to date show that in both common and cold storage there was an increase in the percentage of apples with medium and heavy amounts of internal cork. The trend seems to be toward an increase in the amount of this trouble in storage rather than a decrease. (See photograph on page 53.)

**Tests of Spray Materials.** (O. C. Roberts.) In accordance with a practice which was adopted several years ago, the Departments of Pomology, Entomology, and Botany cooperated in the testing of new spray materials and combinations. Detailed results of the work done this year will be found in the report of the Entomology Department.

**Nutrition of the Highbush Blueberry, Especially in Relation to Soil Reaction.** (J. S. Bailey.) In the fall of 1938 a number of blueberry plants were removed from the nursery, put in Wagener pots, and placed in a storage cellar where the temperature remained just above freezing. Starting on the fourth of January three plants were moved weekly to a warm greenhouse to see how soon the rest period of blueberries is over. The first plants brought in required nearly four weeks before any activity was indicated by a swelling of the buds, and nearly another four weeks before the plants were in bloom. The plants brought in January 30 required about two weeks to show signs of activity and about three more weeks to come into bloom. The plants brought in the third of March showed signs of activity in 5 days and in 19 more days were in bloom. The last plants brought in were in bloom in 24 days as compared with 54 days for the first ones.

The plants used in the experiment above were obtained from a nursery where no evidences of iron chlorosis had ever been observed. They were potted in soil from the nursery. In the greenhouse they were given a liberal supply of a complete fertilizer, watered plentifully, and the temperature, although fluctuating considerably, averaged rather high. This treatment caused the plants to make a very rapid growth, and several of them developed iron chlorosis. This indicates that some soils might be unsuitable for blueberry growing if the plants are forced to grow too rapidly.

Blueberry plants were sprayed with 8 percent solutions of each of the following: ferrous sulfate, ferric chloride, soluble ferric phosphate, and ferric sulfate. These sprays all reduced the chlorosis, but all caused more or less leaf burning.

**Blueberry Culture.** (J. S. Bailey.) Two plants of the Wareham variety in blueberry plot C appear to have a new blueberry trouble discovered in New Jersey by R. B. Wilcox. The symptoms are a shortening of the internodes and a dwarfing and reddish discoloration of the leaves. The whole plant is dwarfed. The cause of this trouble is unknown.

Because of the warm, wet fall and the sudden drop in temperature to -4° F. on November 26, 1938, there was considerable winter injury to blueberries. The variety Cabot was injured much worse than any other. Plants of this variety bore an exceedingly light crop in 1939.

Italian rye grass was tried as a cover crop for blueberries. It was planted about August 15, when the picking season was nearly over, and made a very good growth before cold weather. Since the fall was late and warm, this cover crop probably made a better growth than could be expected in most years. Although it grew very well on soil with a pH of 5.2, it made practically no growth on soil at 4.5. Therefore, it is doubtful if this cover crop will ever prove generally useful for blueberries.

Since the 1939 season was a dry one, the berries were considerably smaller than normal. Winter injury and the dry season reduced the crop about 50 percent.

Buds of two new U. S. D. A. seedlings, GN-45 and GN-87, were obtained from New Jersey by permission of Dr. George M. Darrow of the U. S. D. A. They were budded into several bushes in row A, blueberry plot C. Buds of the U. S. D. A. seedling FI-66, which we have had for several years, and of the variety Dixi, were budded into bushes in this same row to increase the supply of propagating wood.

In the fall of 1939 an experiment was started in blueberry plot D to try a combination of mulching and cultivation. Various mulches, such as sawdust and waste hay are being used in the rows under the plants. The space between the rows will be cultivated.

In the spring of 1939 nine plants of a new seedling, No. 73, were planted in blueberry plot B.

In the spring of 1939 all of the blueberry plants in blueberry plot A were removed with the exception of a few diseased bushes. These diseased bushes will be retained for a short time for further observation.

On June 22 two blueberry plants each of the varieties Rubel, Cabot, and Pioneer were heavily dusted with sulfur at 3 p. m. when the sun was bright and the temperature 80° F. On July 7 there was no sign of injury on any of the plants. At 4 p. m. on that day, which was slightly cloudy, with a temperature of 92° F., these plants were redusted. By July 10 the two Pioneer plants showed severe burning along the edges of the leaves on some of the branches. The other varieties showed no injury at that time or later in the season.

About 350 bushes were removed from the east and south side of blueberry plot D in the spring of 1939. This was done for two reasons: (1) to reduce the size of the planting and thereby reduce the cost of maintenance, and (2) to remove the blueberry bushes from parts of the field not well suited to blueberry growing.

**Premature Dropping of the McIntosh Apple.** (L. Southwick.) Further evidence of the significance of seeds in influencing premature drop of McIntosh apples was obtained. Using the total crops of two trees, correlation coefficients above +.500 indicate considerable association between the number of seeds in an apple and its date of drop and suggest the importance of adequate cross pollination for McIntosh.

Pollen from seven varieties was used on a tented McIntosh tree to check on pollination success. The results indicate that of the varieties commonly considered good pollinators for McIntosh, some are better than others based on the seed counts in this experiment. In general, the severity of pre-harvest dropping seemed to vary with the variety of pollen used on the basis of the number of seeds which developed.

Limb injections of chemical nutrients gave further evidence that abundant nitrogen in the tree tissues hastens McIntosh fruit drop. The mean date of drop of a nitrogen (urea) injected limb was advanced fully four days ahead of similar untreated limbs or limbs injected with non-nitrogenous materials. A potassium sulfate injected limb likewise dropped its fruit relatively early but this probably was due in part at least to rather severe leaf injury. In another single tree test, both the nitrogen injected limbs and the potassium-phosphorus injected limbs dropped their fruit a little earlier on the average than similar untreated branches. However, the differences here were small and conceivably may have been due to the injection procedure itself rather than to the particular materials used. All of these preliminary results are suggestive only, as the data are few and present only one year's observations.

Some McIntosh trees in the Station blocks showed a peculiarly large amount of leaf browning early in September which was followed by severe pre-harvest



fruit drop. Potassium tests made on leaf petioles showed plenty of this element present. A very limited chemical analysis showed a relatively high percentage of total nitrogen in the fruiting spurs on these trees.

Much of these new data seems to support the evidence from field experiments previously reported, that a high state of fertility, especially in relation to nitrogen, tends to increase pre-harvest fruit dropping.

A so-called growth substance, alpha naphthylacetamide, was used to test its effect on delaying normal McIntosh drop. On September 13, 200 gallons of a .00025 percent solution of the chemical in water were made up in a spray tank and the spray applied to alternate trees in two blocks at the usual pressures (300-400 lbs.). The results were largely inconclusive, although in several cases the evidence pointed to a beneficial effect. It is possible that different concentrations and times of application may prove to be of significance. Further work is planned for next year. (See photograph on page 53.)

**Sun Coloring of Apples.** (O. C. Roberts.) McIntosh apples with 0 to 10 percent color were placed in a frame covered with three layers of cheesecloth on September 13. They were removed from the frame after exposure to approximately 80 hours of bright sunshine and were not turned during exposure. When gathered the average color had increased to approximately 60 percent. None of the apples showed sun scald. The quality of the color was duller and somewhat less attractive than on apples which were allowed to color normally.

Ten bushels of Wealthy apples, selected at time of picking for lack of coloration, were spread on a hay mulch underneath a Wealthy tree with dense foliage. After ten days the color had increased from less than 5 percent to more than 50 percent on the surfaces exposed to this indirect light. The under-surfaces did not show any color changes. The flesh texture became noticeably less firm but not enough to adversely affect market value.

## DEPARTMENT OF POULTRY HUSBANDRY

### R. T. Parkhurst in Charge

**Broodiness in Poultry.** (F. A. Hays.) This project has three primary objectives: (1) To secure more data on the inheritance of degrees of broodiness, (2) To study the phases of deferred broodiness, (3) To determine whether a genetically non-broody line of Rhode Island Reds is possible.

The generation hatched in 1938 completed its first laying year in November 1939. This generation came from two sires that were 36 months of age and one sire that was 24 months of age in 1938. The matings gave 38 daughters with complete trapnest records from nine non-broody dams. No daughters gave any manifestation of broodiness in the first laying year. A considerable number of these daughters is being retained for a trapnest record during the second laying year to check on deferred broodiness. Males are constantly being checked genetically for the presence or absence of genes for broodiness.

**A Genetic Study of Rhode Island Red Color.** (F. A. Hays.) A line of birds from an exhibition foundation is being carried forward to study the genetic relationships between plumage color and characters affecting fecundity. The stock is now in the eleventh generation. The data suggest that there may be certain adverse physiological relationships between genes for exhibition color and genes for high fecundity. Data are also being secured on the mode of inheritance of exhibition plumage color.

**Rate of Feathering in Rhode Island Reds.** (F. A. Hays.) Early feathering in Rhode Island Reds may be measured by the development of complete back feathering in males at eight weeks of age. Females in this breed are for the most part well feathered over the back at eight weeks or younger.

Two lines are being developed from the standpoint of dorsal feather growth, and are now in the sixth generation. One line is selectively bred by using sires that have shown complete back feathering; the other has been developed by using sires that have lacked back feathering at eight weeks of age.

A total of 155 cockerels was produced from two sires in the early-feathered line. The first sire gave 69 percent early-feathered sons, and 18 percent of his sons showed tail development at 12 days of age; 12 percent of his daughters had tail development at 12 days. The second sire in this line gave 63 percent early-feathered sons and 26 percent of his sons showed tail development at 12 days; 51 percent of his daughters had tail development at 12 days. The 155 males in the early-feathered line gave 65 percent early feathered, and about 24 percent had tail development at 12 days. The development of back feathering was not closely related to the development of tail growth at 12 days, the latter apparently being due to the sex-linked gene reported by Warren in Leghorns. In the early line there were four families in which all males had complete back feathering.

The late line consisted of 36 males and 32 females from five different families, all sired by one late-feathered male. These males showed 100 percent late feathering at 12 days and at 8 weeks of age. The females also showed 100 percent late feathering at 12 days.

The data so far collected seem to indicate that early feathering in the dorsal region in males is due to several recessive autosomal genes and that a sex-linked recessive need not be present to produce the desired phenotype. Barred Plymouth Rock chicks in the Station flock show a high degree of back feathering but not a single individual has shown tail development at 12 days.

**The Effectiveness of Selective Breeding to Reduce Mortality in Rhode Island Reds.** (F. A. Hays.) Cooperative project with Regional Poultry Research Laboratory, East Lansing, Michigan. Two lines are being developed by selective breeding: one selected for low mortality in the laying houses and the other for high mortality in the laying houses. Selection of breeding stock to reproduce these two lines is based entirely upon mortality rates with no consideration given to fecundity characters or to egg characters. The fifth generation, hatched in 1938, has completed a full laying year.

In the low mortality line 49 pullets were placed in the laying houses and 20 individuals died, giving a mortality rate of 40.82 percent. Eleven birds died from cannibalism, six from undetermined causes and one each from ruptured yolks, tumors, and prolapsus of the oviduct. The death rate was excessive because of the high incidence of cannibalism.

In the high mortality line 43 pullets were housed. The loss in the first laying year was 25 birds, giving a mortality rate of 58.14 percent. Seven birds died from cannibalism, 12 from undetermined causes, 3 from ruptured yolks, 1 from a cholera-like disorder, and 1 from prolapsus of the oviduct. In this line there was one pullet that survived but never laid and another that laid but 36 eggs.

The sixth generation was hatched in 1939. In the low mortality line 135 chicks were hatched, and the mortality to six months of age from all causes was 6.6 percent. In the high mortality line there were 153 chicks, with a mortality rate of 10.46 percent for the first six months. There was one case of neurolymphomatosis.

In the low mortality line 45 pullets were placed in the laying houses and 41 cockerels were retained. These represent complete families. To December 1, 1939,

2 pullets have died from cannibalism and none from diseases or disorders, and no cockerels have died. In the high mortality line 46 pullets were housed and 47 cockerels were retained, all representing complete families. No losses of pullets or cockerels have occurred to December 1, 1939.

**Genetic Laws Covering the Inheritance of High Fecundity in Domestic Fowl** (F. A. Hays and Ruby Sanborn.) Major objectives in this project are: (1) developing a line that is genetically pure for sexual maturity at 180 to 215 days, (2) fixing high intensity so that the winter clutch size will exceed 3, (3) eliminating all inherited winter pause, (4) eliminating the broody instinct, and (5) fixing genetically high persistency. In addition to the above characters, studies are also being made on fertility, hatchability, chick feathering, body weight, egg weight, plumage color, comb type, shank feathering, and inherited factors affecting mortality rate.

Mortality rate in the laying house was higher in the 1938 flock than in the three previous flocks, largely because of the paralysis complex of diseases. Special selective breeding to avoid the paralysis complex was used to produce the flock hatched in 1939. Up to December 1, 1939, no paralysis has occurred in this generation.

Experimental crosses with outside stock are being made to check the genetic behavior of characters being studied. The experimental line started in 1913 is also being maintained.

During the year, Bulletins 359 and 365 have been published on this project, and Bulletin 307 has been enlarged and revised.

**A Study of Fertility Cycles in Males.** (F. A. Hays.) This project began in the late summer of 1939. Material is now being collected for studying the stages of spermatogenesis in males of various ages through the winter season.

**Physiological Relationships Between Molting Behavior and Fecundity Characters.** (F. A. Hays.) Biweekly observations on the molting behavior of a group of exhibition and production Rhode Island Red males and females was begun July 27, 1939. These and previous observations will serve as a guide to the first breeding phase to be undertaken in the spring of 1940.

**The Technique of Testing Vitamin D Carriers with Chicks.** (A. O. A. C. method). (R. T. Parkhurst.) Tests are being made of the vitamin D potency of various cod liver oils, sardine oils, fortified cod liver oils, and fortified sardine oils in cooperation with the Feed Control Service and the Nutrition Laboratory. Future work will include other types of carriers. A real need for authentic information regarding claimed potencies is indicated.

## SEED CONTROL SERVICE

Philip H. Smith in Charge

**Seed Inspection.** (F. A. McLaughlin and Jessie L. Anderson.) From December 1, 1938, to December 1, 1939, the Seed Laboratory received and worked 2663 samples of seed, of which 1003 were collected by the State Commissioner of Agriculture and 1661 were sent in by seedsmen, farmers, and various state institutions. An additional lot of 224 samples of flower seeds, for field tests only, was also received from the State Commissioner of Agriculture.

Classification of these samples with the total number of laboratory tests involved is shown in the following summary. It will be noted that the total number of tests required for the 2663 samples was 3763; 857 for purity and 2906 for germination.



Samples	Purity	Germination
644 Field Crops for Purity and Germination.....	644	644
14 Field Crops for Purity Only.....	14	...
123 Field Crops for Germination Only.....	...	123
103 Lawn and other types of Mixtures for Purity Germinations involving 456 ingredients.....	103	456
96 Lawn Mixtures for Purity Only.....	96	...
1501 Vegetable Seeds for Germination Only.....	...	1501
37 Flower Seeds for Germination Only.....	...	37
22 Tree Seeds for Germination Only.....	...	22
123 Tobacco Seeds for Germination Only.....	...	123
2663	857	2906

Field tests to determine trueness to type were conducted in cooperation with the Departments of Vegetable Gardening, Floriculture, and Agronomy, which tested respectively, 193 samples of Vegetable seeds, 224 samples of Flower seeds, 20 samples of Oats, and 73 samples of Corn. All samples for these tests were collected and submitted by the State Commissioner of Agriculture, with the exception of 4 samples of Oats, which were sent in by seedsmen.

The Seed Laboratory cleaned 7 lots of Onion seed and 73 lots of Tobacco seed for Connecticut Valley farmers.

Corn, oats, barley, and wheat purchased by various State institutions (179 samples) were examined for conformity to grade purchased; and 103 samples of ground cattle and poultry feed, collected by inspectors or sent in by dealers and farmers, were examined microscopically.

## DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

**Poultry Disease Control Service.** (H. Van Roekel, K. L. Bullis, O. S. Flint, and M. K. Clarke.)

1. *Pullorum Disease Eradication.* During the 1938-39 season 365 flocks (including 10 flocks other than chickens) were tested. A total of 623,935 tests (including 3,565 paratyphoid tests) was made on blood samples received from 12 counties. Norfolk, Worcester, and Middlesex Counties led in the number of birds tested. The average percentage of reactors was 0.34, which is a slight increase over the previous season. The increase in reactors is due to the detection of infected birds in one large flock which had no infection the preceding season. Reactors were detected in all of the more common breeds of chickens. No infection, either pullorum or paratyphoid, was found in fowl other than chickens.

A total of 298 non-reacting flocks (100 percent tested, representing 440,689 birds) was identified. The value of these birds is expressed by the increased egg production, increased fertility and hatchability, and high chick livability which represent an inestimable monetary saving to the poultry industry of this and other states of this country.

Infection was discovered in 10 flocks which were negative the previous season. The source of the infection was determined in some of these flocks. It may be concluded from these "breaks" in negative flocks that annual testing of all birds on the premises, plus effective precautionary measures against the introduction of infection, is necessary to keep the spread of pullorum disease at a minimum.

The growing interest in pullorum disease eradication in Massachusetts for the 1938-39 season is manifest by increases in tested flocks (47), tested birds (90,838), tests (117,436), and non-reacting flocks (41).

During the past year this department has continued to cooperate with the Massachusetts Department of Agriculture by making available testing results which are used for official recognition and classification of pullorum tested flocks.

2. *Diagnostic Service.* A total of 751 consignments, which included 3,682 specimens, was received during the past year,—an increase of 91 consignments and 1,065 specimens over the previous season. Personal delivery of specimens was made in 465 cases. The classification of the specimens is as follows:

Bovine.....	2	Goose.....	1
Bovine liver.....	1	Guinea fowl.....	1
Bovine semen.....	4	Guinea pigs.....	4
Calf.....	1	Mink.....	8
Canary.....	1	Mink feces.....	2
Canine.....	2	Pheasants.....	43
Canine feces.....	91	Pigeon.....	1
Canine skin scrapings.....	1	Quail.....	3
Chickens.....	3,054	Rabbits.....	3
Duck.....	4	Ruffed grouse.....	2
Feed.....	2	Sheep.....	2
Feline.....	4	Swan.....	1
Foxes.....	3	Swine.....	11
Fox lung.....	1	Swine liver.....	1
Goat feces.....	1	Turkeys.....	427
Total.....			3,682

Disease conditions noted most frequently in the chickens were coccidiosis, tumors, fowl paralysis, pullorum disease, and infectious bronchitis. Fowl cholera was identified in 16 cases, 9 of which represent new known foci of infection. Fowl typhoid was noted in 11 cases. These diseases can no longer be considered rare, although fowl typhoid infection in particular seems to be limited to small areas within the State. Avian tuberculosis was observed in birds from three premises.

The increased interest and expansion in turkey raising in Massachusetts have resulted in a considerable increase in the number of diseased turkey specimens for the diagnostic service. A comparison of the number of consignments and the number of turkey specimens for the past five years is presented below:

	1934-35	1935-36	1936-37	1937-38	1938-39
Cases.....	17	28	26	44	71
Specimens.....	84	145	184	172	427

The more important and the more frequently occurring diseases noted in the turkey specimens are listed in the following five-year comparative summary:

	1934-35	1935-36	1936-37	1937-38	1938-39	Total
Coccidiosis.....		4	4	8	5	21
Enterohepatitis.....	6	6	3	9	7	31
Fowl pox.....				3	2	5
Fowl typhoid.....	1		1		4	6
Moniliasis.....				1	3	4
Paratyphoid.....	1	2	3	2	16	24
Perosis.....	6	1	1	1	1	10
Pullorum disease.....		4	1	3	9	17
Rickets.....	1	3	3	3		10
Staphylococcosis.....			2		1	3
Swine erysipelas.....		2	1		2	5
Ulcerative enteritis.....		4	4	3	2	13

3. *Pasteurella* and *Pasteurella-like* Cultures (*Avian Origin*). Some physiological characteristics and the pathogenicity of 61 such cultures were examined. The typical *Pasteurella* cultures fermented mannite, produced indol, and were pathogenic for rabbits, while the *Pasteurella-like* cultures were mannite- and indol-negative and non-pathogenic for rabbits. Strains of the latter group did, however, produce a disease condition in chickens which was represented largely by inflammation and pus formation in the tissues in the region of the tibio-metatarsal joints. Because of difficulties encountered in routine work in obtaining satisfactory growth in carbohydrate media with *Pasteurella* cultures, 23 media were tested. A medium containing 1.0 percent peptone, 0.3 percent meat extract, 0.5 percent sodium chloride, and 1.0 percent of the desired carbohydrate was the most satisfactory.

4. *Avian Encephalomyelitis*. Investigations concerning avian encephalomyelitis ("epidemic tremor") have revealed that the disease is becoming a more serious problem to the hatchery and baby chick industries. Field and laboratory findings strongly suggest that the infective agent is transmitted through the egg from the hen to the progeny. Transmission in the incubator through direct contact is also suspected because the disease has spread among chicks through direct contact during the brooder stage.

The infective agent has been passed through 92 serial passages in chicks. Strain differences in susceptibility were observed among experimental chicks. Turkey poults and ducklings were found to be susceptible to the disease upon inoculation. White mice, rabbits, guinea pigs, mature pheasants, and sparrows were found to be refractory.

A more detailed report of these investigations was published in *Veterinary Medicine* 34 (No. 12):754, 1939 (Contribution 355).

5. *Equine Encephalomyelitis Virus (Eastern Type)*. During the past year a strain of equine encephalomyelitis virus (eastern type) was isolated from a pheasant brain which was received from Dr. F. R. Beaudette, New Jersey Agricultural Experiment Station. This observation was made at the same time other investigators discovered this infection among pheasants and pigeons in Connecticut and Massachusetts. These findings represent the first definite isolation of the infective agent from naturally infected wild birds. Host susceptibility experiments revealed that the English sparrow and purple grackle can be added to the list of susceptible hosts, including man. The results of these investigations were published in the *Journal of American Veterinary Medical Association* 94 (n. s. 47):466-468, 1939 (Contribution 344).

6. *Viability of S. pullorum*. Viability studies, which are still in progress, show that *S. pullorum* has remained alive in a dry piece of cloth for a period of seven years. The remarkable ability of a vegetative organism of the nature of *S. pullorum* to remain viable over such a long period may give an insight into some of the practical eradication and prevention problems of pullorum disease.

7. *Pullorum Disease in Turkeys*. A study of pullorum reacting turkeys for a period of approximately 18 months (including two laying seasons) has revealed that the causative agent (*S. pullorum*) may be eliminated through the egg in two successive laying seasons. Repeated agglutination tests, using the macroscopic tube method, disclosed that infected turkeys may exhibit a variety of titres. Among the 19 turkeys necropsied during the course of the experiment, *S. pullorum* was isolated from five. The agglutination titres of these five infected turkeys at the time of necropsy were 1:10, 1:20, 1:40, 1:40, 1:640. Two of the infected birds previously had exhibited a titre of less than 1:10. These observations should have a significant influence in combating the spread of pullorum infection among turkeys and other poultry.



8. *Farm Department Brucellosis Control and Eradication.* The laboratory cooperated in this work by testing the following blood samples for *Brucella* infection: 674 bovine, 60 porcine, and 1 equine. The standard tube agglutination method was used.

**Studies of Neoplastic and Neoplastic-like Diseases.** (Carl Olson, Jr.) The transmissible lymphoid tumor of the chicken whose origin was described in a previous Annual Report (for Year Ending November 30, 1938) has been carried through 39 serial passages. No change in the type of disease produced has been observed. Successful transmission of the disease has apparently been dependent upon the presence of living cells in the material used for transplantation. In some instances whole blood of birds with the tumor has been used successfully as an inoculum. Attempts to obtain an active extract from the tumor tissue have thus far been negative. Regression of the transplant after a period of active growth was noted in some chickens and further inoculations of transplants in these chickens have failed to grow. Transplants of the tumor did not grow in new sites in chickens in which growth of a previous transplant had become well established. Transplants of the tumor grew readily, however, in chickens spontaneously affected with fowl paralysis. This would seem to indicate a difference in the pathological lymphoid tissue concerned in these two diseases.

Attempts have been made to transmit experimentally other spontaneous cases of neoplastic disease (some similar to the above and others dissimilar) and some spontaneous cases of fowl paralysis. To date such transmission has not been observed.

Nearly 300 instances of spontaneous neoplastic disease have been collected among chickens derived from various sources. This material is being studied to determine the relative incidence as well as the characteristics of the various types of neoplasia.

Observations on the antigenic properties of chicken erythrocytes have been made during the past three years. Previous work by other investigators has indicated that the individual components of the antigen mosaic of the chicken erythrocyte are for the most part inherited as dominant properties, although there are some whose presence indicates a complicated inheritance. This phase of work was entered upon as an adjunct to the inbreeding of a group of chickens for the purpose of securing experimental stock of relatively similar genetic constitution. For the purpose of studying the blood cells of these chickens the method of Landsteiner and Levine (*Soc. Expt. Biol. and Med. Proc.* 30:209-212, 1932-33) was followed. In this method advantage is taken of the ability of serum of normal cattle to agglutinate erythrocytes of chicken blood. By cross absorption tests the erythrocytes of individuals of a group of chickens may be shown to have a different antigenic structure. Differences in the agglutinating ability of serums from different cattle were found and in this work serum from the same cow was used in the successive tests.

The group of chickens upon which these observations were made included an original lot of inbred birds and two succeeding generations of progeny from this original lot. The original group of 21 birds were brothers and sisters. They had only five individuals for great-grandparents instead of a possible eight; two of the grandparents were brother and sister and two others were sired by the same male (half brother and sister). The two succeeding generations from this stock have resulted from the mating of brother and sister. Three groups or types of erythrocytes have been classified in these chickens by the method employed. Group I erythrocytes are characterized by the ability to remove all agglutinating power of the particular cow serum used in these tests for erythrocytes of other chickens in this family. Group II erythrocytes have the ability to remove the agglutinating ability of the cow serum for only the erythrocytes of the same

group, that is Group II. Group III erythrocytes have the ability to remove the agglutination power of the cow serum for erythrocytes of Group III and Group II, but do not affect the ability of the serum to agglutinate Group I erythrocytes. The classification of the erythrocytes of the parents of the original group of chickens is not known. Of the original group, six chickens (28.6 percent) had erythrocytes belonging to Group I, four chickens (19.0 percent) had erythrocytes belonging to Group II, and eleven chickens (52.4 percent) had erythrocytes belonging to Group III. The next generation was from a male having erythrocytes of Group I and a female with Group II erythrocytes. Most of the progeny of this mating had Group III erythrocytes, (17 chickens—94.5 percent) and one only had Group I erythrocytes. It is probable that some with Group II erythrocytes might have been found had more progeny of this mating been tested. The third generation tested was from a mating of a male and female both of which had Group III erythrocytes. Of those tested, nine (24.3 percent) were Group I, twelve (32.4 percent) were Group II, and sixteen (43.3 percent) were Group III. A complicated system of inheritance of erythrocyte type is suggested by the presence of Group I erythrocytes in the progeny where both male and female have only Group III erythrocytes.

### WALTHAM FIELD STATION

(Waltham, Massachusetts)

Ray M. Koon in Charge

The members of the research staff of the Waltham Field Station are assigned to the unit by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Reports of these departments give results of investigations conducted at this branch station.

**Consultation and Information Service.** A definite increase was noted in the number of commercial vegetable growers, orchardists, florists, nurserymen, arborists, professional gardeners, greenkeepers, and amateurs who came to the Field Station this year to personally consult members of the staff. Many of these organizations now hold meetings at the Station at irregular intervals, and the Executive Committee of the Boston Market Gardeners Association meet regularly once a month.

**Evaluation Gardens.** In a garden of 1500 species and varieties of herbaceous ornamentals, all have been rigorously discarded which fail to qualify as hardy, or are otherwise unsatisfactory in the latitude of Massachusetts. This has resulted in a collection of real importance to nurserymen and landscape and amateur gardeners. The value of such a collection, well grown and accurately labeled, is evidenced by visits from over 3000 persons during the flowering season.

**Field Day.** Perfect weather brought out 1250, a record attendance for the twenty-first annual Field Day on August 2. Considered from all angles, it was the most successful Field Day conducted by the Field Station. Exhibitors report greatly increased interest on the part of the visitors in the mechanical equipment they display. Interest in the celery contest was especially keen this year as the new Summer Pascal variety was exhibited for the first time by local growers.

**Soil Testing Service.** The demand for the soil testing service is increasing and it is believed that the interpretation of the tests will contribute to a better understanding of some of our soil fertility problems.

**Massachusetts Nurseryman.** Reports of findings and other pertinent information are mailed to commercial producers of ornamental plants nine times a year in mimeograph form called the "Massachusetts Nurseryman."

## PUBLICATIONS

## Bulletins

- 307 Breeding for Egg Production. By F. A. Hays and Ruby Sanborn. 36 pp. June 1939.

A revised and enlarged edition of a bulletin first published in 1934, presenting results obtained during 25 years of breeding work. It is intended as a guide to assist the poultry breeder in directing his operations.

- 342 Facts, Fads, and Frauds in Nutrition. By Helen S. Mitchell and Gladys M. Cook. 31 pp. April 1939.

A reprint of a bulletin issued in April 1937, somewhat revised and brought up to date by the inclusion of statements regarding the Food, Drug and Cosmetic Act. Valuable as a guide to the consumer.

- 355 Annual Report for the Fiscal Year Ending November 30, 1938. 104 pp. February 1939.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

- 356 Field Corn in Massachusetts. By William G. Colby and Ralph W. Donaldson. 16 pp. February 1939.

This study was undertaken to determine the climatic adaptation of a large number of hybrid and open-pollinated corn varieties and also to review the practices necessary for successful corn culture in this State. A list of varieties tested, with maturity dates and yields over a three-year period, is appended to furnish a basis for determining the suitability of varieties for particular areas.

- 357 The Effect of Feeding a Vitamin A Supplement to Dairy Cattle. By J. G. Archibald and C. H. Parsons. 14 pp. March 1939.

A vitamin A supplement in concentrated form was added to the grain ration fed to dairy cattle during a period of 22 months to study its effect on the growth and productive function of the animals as well as on milk production. The results, although favorable to the supplement in their trend, were not marked. However, since these cows were on better-than-average rations, it is reasonable to assume that response to the supplement might be greater under average farm conditions, and the slight additional cost of grain mixtures fortified with a vitamin A concentrate seems a cheap insurance against troubles due to deficiency of this vitamin, particularly when the roughage is of poor quality.

- 358 Blueberry Culture in Massachusetts. By John S. Bailey, Henry J. Franklin, and Joseph L. Kelley. 20 pp. February 1939.

This is a complete revision of a previous bulletin on blueberry culture published in 1935 as Bulletin 317, and contains information on soil requirements, selection of varieties, methods of propagation and culture, pruning, insect and disease control, harvesting, and marketing of cultivated blueberries. Suggestions are given for the improvement of the wild high-bush blueberries which occur so abundantly in Massachusetts.

- 359 Factors Affecting Fertility in Rhode Island Reds. By F. A. Hays and Ruby Sanborn. 15 pp. May 1939.

A report on the behavior of fertility in a breeding program extending over 15 years. Outside temperature during the period when hatching eggs are laid had a specific effect on fertility—fertility increased steadily as outside temperatures rose to about 37° F. Both males and females showed a decline in fertility with increasing age, a decline less marked in females than in males. All the evidence indicates that fertility is controlled by factors other than inheritance and that selective breeding to improve fertility would, therefore, be ineffective.

- 360 Farm Storages for New England Apples. By C. I. Gunness, W. R. Cole, and O. C. Roberts. 32 pp. March 1939.

Information on design and structure of common and cold storage buildings, refrigeration equipment and operation, management of storage houses, temperature and humidity control, and the physiology and hand-



ling of the fruit occupies most of the bulletin. Tests showed that apples which are to be held for a long period should be stored at 32° F. McIntosh apples develop better flavor if the temperature is held at 45° at the time of harvest and reduced to 32° by the third week after picking, but this higher temperature should not be used if the apples are to be held later than January 1.

- 361 Control of Tomato Leaf Mold in Greenhouses. By E. F. Guba. 36 pp. April 1939.

The successful control of the disease involves cultural practices, greenhouse management, greenhouse location and design, and the use of chemicals for the disinfestation of the greenhouse interior and the protection of the plants from infection. All these factors are discussed and recommendations based on experimental results are made.

- 362 Haying in the Rain: A Study of Grass Silage. By J. G. Archibald and C. H. Parsons. 19 pp. April 1939.

Unlike corn, grass and legumes require the addition of a preservative at the time the silo is filled in order to make satisfactory silage. At present molasses seems most satisfactory for this purpose from the standpoint of both economy and results, although phosphoric acid may be used. Detailed directions are given for ensiling grass and legumes, using molasses. Feeding trials showed that the molasses-grass silage was about equal to corn silage and somewhat superior to dry hay, although it probably should not entirely replace hay in the ration. It differs only slightly from hay in cost and is generally less expensive than corn silage.

- 363 Milk Cartage in the Southwick-Agawam Area of the Springfield Milk Shed. By Alfred A. Brown and J. Elizabeth Donley. 26 pp. May 1939.

Analysis of this section of the Springfield milkshed showed that the present type of service under a variety of rates has provided producers with adequate transportation, but the cost has been high, largely because of excessive mileage, light loads, extreme variation in load size, unused truck capacity, and the like. Two plans are suggested for improving the situation: the first is based on reorganization of routes whereby the number of routes was reduced from 12 to 4 and the mileage was reduced more than one third; the other was a reorganization of rate structure by zones.

- 364 The Significance of Body Weight in Breeding for Egg Production. By F. A. Hays. 16 pp. June 1939.

An analysis of the records of 2,283 Rhode Island Red pullets showed considerable parallelism between monthly body weight and monthly egg weight and egg production. Maximum egg weight occurred about one month earlier than maximum body weight, and the highest level of egg production occurred when body weight was at its maximum in March and April. Figures showed that removal of light-weight pullets on March 1 is an effective means of reducing subsequent mortality. In general, body weight offers a valuable guide to the breeder, particularly from the standpoint of egg size and laying-house mortality.

- 365 Product-Costs of Milk to Dealers in the Springfield Area, 1935. By Alfred A. Brown and J. Elizabeth Donley. 28 pp. July 1939.

Variations in product-costs (weighted average cost to dealers of milk purchased from producers) in the area are analyzed and suggestions made for reducing them. The milk industry can perform its most effective service under conditions of relative market stability. Among conditions found not conducive to market stability and orderliness are uneven distribution of fluid outlets among dealers, rigidities in producer-distributor relationships, and the absence of reasonable relationships between the price payable for milk disposed of as fluid and as surplus. The disadvantages suffered by all producers, but mostly by producers with inferior sales' outlets, should be minimized by the development and application of a logical pricing technique based on "normal" class price relationships.

- 366 Towards a Perfect Milk Market. By J. Elizabeth Donley. 28 pp. November 1939.

A normal market should show little duplication of services in procuring its milk and have little surplus at any time of year. This study made in 1935 showed Worcester to be such a market — the producer sells his milk regularly throughout the year, the dealer has very little surplus to

dispose of, and the consumer is assured of a regular supply of good milk. The transportation phase seems to be the only part which might be more efficiently organized, but this would involve government control which might prove less desirable than the condition it seeks to remedy.

- 367 Meteorological Records: A Fifty-Year Summary, 1889-1938. By C. I. Gunness. 23 pp. December 1939.

A summary by months of barometer readings, temperature and humidity, cloudiness and sunshine, precipitation and snowfall, and wind movement for the fifty years that records have been kept at the College. The hurricane of September 21, 1938, was the outstanding storm during this period, and details of the weather on that day are given, with a chart showing the behavior of barometric pressure and wind velocity.

- 368 Cephalosporium Elm Wilt in Massachusetts. By Malcolm A. McKenzie and Eunice M. Johnson. 24 pp. December 1939.

This disease is rather widespread in Massachusetts and has been the subject of field and laboratory investigations over a period of several years. The macroscopic symptoms are similar to those of the Dutch elm disease, and the fungus which causes the disease is believed to be widely distributed throughout the United States. Affected trees may be progressively weakened and killed, although some trees have apparently recovered and some trees growing in favorable locations seem to be free from symptoms although they do harbor the fungus. Under greenhouse conditions the progress of the disease appeared to be limited in trees infected with a second wilt-inducing fungus, *Verticillium* sp., in addition to *Cephalosporium* sp., since trees infected with both of these fungi did not die back so rapidly as trees infected with either one of the fungi alone.

### Control Bulletins

- 98 Nineteenth Annual Report on Eradication of Pullorum Disease in Massachusetts. By the Poultry Disease Control Laboratory. 12 pp. June 1939.
- 99 Inspection of Commercial Feedstuffs. By Philip H. Smith. 69 pp. November 1939.
- 100 Inspection of Commercial Fertilizers. By H. D. Haskins. 50 pp. December 1939.
- 101 Inspection of Agricultural Lime Products. By H. D. Haskins. 10 pp. December 1939.
- 102 Seed Inspection. By F. A. McLaughlin. 104 pp. December 1939.

### Meteorological Bulletins

- 601-612, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By C. I. Gunness. 4 pp. each.

### Reports of Investigations in Journals

#### Numbered Contributions

- 305 Cranberry juice—properties and manufacture. By C. C. Rice, C. R. Fellers and J. A. Clague. Fruit Produce Jour. 18(7):197-200. 1939.

The juice of the cranberry is well flavored, tart, and attractively colored, and when properly sweetened it makes a very desirable drink. Two methods of expressing the juice are described—heat extraction and cold pressing—and directions are given for making various beverages and syrups. Cranberries and the freshly expressed juice are excellent sources of vitamin C, but some of the vitamin is lost in the manufacturing processes and in storage.

- 309 Larval development of the native elm bark beetle, *Hylurgopinus rufipes* (Eich.), in Massachusetts. By W. B. Becker. Jour. Econ. Ent. 32 (1): 112-121. 1939.

A study of native elm bark beetles, collected weekly from logs cut from a single American elm and stored in a shaded location, indicates that five stadia occur most commonly, that there was some overlapping in size of successive instars in some cases, and that a difference in size distribution due to sex began to be noticeable in the last two instars.

- 310 The nutritive value of dried tomato pomace. By W. B. Esselen, Jr., and C. R. Fellers. *Poultry Sci.* 18(1):45-47. 1939.

This is a waste product from the manufacture of tomato juice and pulp, and consists mainly of skins, seeds, and hard tissue. The data show it to be a good source of vitamin B<sub>1</sub> and a fair source of A and G (B<sub>2</sub>). It was readily eaten by chicks from 2 to 6 weeks of age, when fed at the 11.6 percent level. Because of its bitterness, large amounts would probably prove unpalatable to animals.

- 311 The nutritive value of distillers' by-products. By A. D. D'Ercole, W. B. Esselen, Jr., and C. R. Fellers. *Poultry Sci.* 18(1):89-95. 1939.

Dried distillers grains or concentrated slop — 10 to 15 percent added to poultry rations — will provide a good and economical source of vitamins B<sub>1</sub> and B<sub>2</sub>, which are essential for poultry growth and reproduction.

- 314 Seasonal variation in chemical composition of common haddock. G. Chapman Crooks and W. S. Ritchie. *Food Research* 4(2):159-172. 1939.

Water, ash, ether extract, organic nitrogen, ammonia, copper, iron, manganese, and phosphorus were determined in four series of haddock samples caught over a period of one year. The four series included fish frozen whole at sea by means of solid carbon dioxide as soon as caught, fish frozen whole by the Birds Eye method as soon as landed, and commercial fillets frozen by both the Birds Eye and sharp methods. No significant differences were found in the composition of the samples frozen by the various methods, but there was a suggestion of some seasonal variation in certain constituents.

- 317 Effect of pectin supplements on avitaminosis A in rats. By A. Kobren, C. R. Fellers and Wm. B. Esselen, Jr. *Proc. Soc. Expt. Biol. and Med.* 41:117-118. 1939.

The pectin appeared to be beneficial in avitaminosis A only insofar as pathological changes in vagina, nares, and eyelids were concerned. It did not delay onset of xerophthalmia, nor did it have any curative action in this condition.

- 318 Nutritional gizzard lesions in chicks. William B. Esselen, Jr. *Poultry Sci.* 18 (3):201-209. 1939.

The Massachusetts State College chick ration gave practically complete protection against gizzard lesions. A study of the various ingredients and combinations of them showed that 15 percent each of wheat middlings, wheat bran, and oat groats and 4 percent of alfalfa leaf meal added to the basal lesion-producing ration was almost as effective as the Massachusetts ration. In curative studies alfalfa leaf meal was the most effective of the single materials studied, but the Massachusetts ration which was effective in preventing the lesions was also a very good curative agent. Chicks do not store any great amount of the anti-gizzard-lesion factor in their bodies, but need a constant supply in their feed.

- 319 The oxidation of ascorbic acid as influenced by intestinal bacteria. By William B. Esselen, Jr., and James E. Fuller. *Jour. Bact.* 37(5):501-521. 1939.

Certain bacteria, particularly members of the coliform group, inhibited the oxidation of ascorbic acid in culture media. This inhibitory action was stronger with the more actively growing cultures in which the largest number of bacteria were present, and was not observed in the killed cultures. It is suggested that growing bacteria inhibit the oxidation of ascorbic acid by certain combinations of three factors: the formation of un-ionized copper complexes whereby the catalytic action of the copper is destroyed; the production of carbon dioxide with the subsequent saturation of the medium with it; and the lowering of the oxygen tension of the medium. The most effective inhibitory action was obtained with a combination of all three of the factors.

- 320 Effect of particle size on the solubility of magnesium in dolomite and magnesic limestone in 4 percent citric acid solution adjusted to pH 4.0 with ammonium hydroxide. By J. W. Kuźmeski. *Jour. Off. Agr. Chem.* 22 (1):147-150. 1939.

The results seem to justify the belief that the solubilities recorded might have a definite ratio to the rate of solubility or availability of



the magnesium and calcium in a limestone product in the soil. They also emphasize the great advantage of fine grinding from the standpoint of immediate effectiveness of the product, both in neutralizing value and in furnishing available plant food.

- 321 The effect of apples and cranberries on calcium retention. By Abraham Mindell, William B. Esselen, Jr., and Carl R. Fellers. *Amer. Jour. Digest. Diseases* 6(2):116-119. 1939.

Body calcium retention of white rats was increased 8.4 percent when fresh cranberries made up to 20 percent of an adequate diet, and 10.8 percent when apples were fed at the same rate. Cranberries seemed to increase the calcium content of the femur ash slightly, but apples showed no significant effect.

- 322 Dextrose in the food industries and its health status. By Carl R. Fellers. *Amer. Jour. Pub. Health* 29(2):135-138. 1939.

Dextrose can be advantageously used to replace from 15 to 50 percent of the sucrose in the manufacture of fruit preserves, jams, fruit syrups, sweet pickles, and certain canned foods such as apple sauce, peaches, pears, peas, and citrus juices. Dextrose is somewhat superior to sucrose in preservative action, especially at higher concentrations, and because of its lower sweetening power, it does not mask the fruit flavor so much as equivalent quantities of sucrose.

- 325 Factors to be considered in selecting chocolate-flavored milk. By W. S. Mueller. *Jour. Dairy Sci.* 22(8):623-636. 1939.

Ordinary amounts of cocoa (1 percent) do not decrease the nutritive value of milk, but 4 percent definitely decreases the digestibility of the milk. The bacteria count of some of the commercial chocolate-flavored syrups was high enough to cause considerable contamination when they were added to cold milk, although no pathogenic organisms were found in any of the syrups or cocoas.

- 326 Influence of bacteria on oxidation of ascorbic acid. By William B. Esselen, Jr. *Food Research* 4(4):329-334. 1939.

Most of the 45 strains of bacteria studied significantly retarded the oxidation of ascorbic acid, especially when they were grown in a medium containing a readily fermentable carbohydrate. There was no evidence that bacteria are destructive to ascorbic acid. It would appear, therefore, that bacteria are not of importance in causing a loss of ascorbic acid in foods.

- 327 Canned baked apples. By John Ruffley, Jr., John A. Clague, and Carl R. Fellers. *Canning Age* 20(2):68-70, 82 and (4):179-181. 1939.

Baked apples make a satisfactory canned product, but glazed apples are more attractive and finer flavored and take less time. For either baking or glazing a syrup of not more than 40° Brix is recommended, and the use of 5 percent honey or 20 percent dextrose with the sucrose gives good results. For hot-filled No. 2 cans, processing for 12 minutes at 212° F. insures sterilization. Varieties of moderately high acid and pectin, such as Baldwin, York, Rhode Island Greening, Gravenstein, and Northern Spy, are good for baking and canning.

- 328 Dealing with storm damage in central Massachusetts. By Malcolm A. McKenzie. *Eastern Shade Tree Conf. Proc.* 1938:29-34. 1939.

A discussion of the damage to shade trees by the hurricane of September 21, 1938, telling what has been done to restore and replace trees which were damaged or destroyed and warning of the danger of disease and insect injury which is likely to follow the hurricane damage.

- 329 Present status of pullorum disease in the United States. By Henry Van Roekel. *Proc. Seventh World's Poultry Congress and Exposition, Cleveland, Ohio*, 1939.

Testing data from various states are presented to show that pullorum disease-free flocks can be established and maintained and that pullorum disease control and eradication are progressing rapidly in many states.

- 330 A quantitative study of form and size in five varieties of carrots. By W. H. Lachman. *Amer. Soc. Hort. Sci. Proc.* 36(1938):623-625. 1939.

While there is some variability in both shape and size of carrots, it is apparent that shape is decidedly the more constant of the two characters

and is less influenced by soil variability. When studied on a statistical basis, shape indices may be manipulated with confidence and small though clear-cut differences may be ascertained.

- 331 New and easy ways to prevent damping-off of seedlings. By W. L. Doran. *Amer. Florist* 1(2):2. 1939.

Ordinary vinegar is a good disinfectant for preventing damping-off of seedlings when applied to soil at the rate of 1 pint per square foot before the seed are sown. After sowing small seeds, it is a good practice to water the soil from below by setting the containers into shallow pans of water and removing them as soon as the soil becomes saturated; and if preferred, a soil fungicide may be applied at this time. Satisfactory control of damping-off without injury to the seeds has been obtained by 1½ quarts of vinegar or 2 to 3 teaspoonfuls of formaldehyde to a gallon of water, applied in this way.

- 332 Relation of seeds to pre-harvest McIntosh drop. By Lawrence Southwick. *Amer. Soc. Hort. Sci. Proc.* 36(1938):410-412. 1939.

A moderate but statistically significant correlation was found between seed number and time of pre-harvest drop of the McIntosh apple. Seed number varied widely for different trees, probably as a result of variability in the effectiveness of pollination, but this did not seem to alter appreciably its association with the date of drop.

- 333 Further notes on the Malling clonal stocks in relation to McIntosh and Wealthy. By Lawrence Southwick and J. K. Shaw. *Amer. Soc. Hort. Sci. Proc.* 36(1938):113-137. 1939.

Variability studies indicate that very little benefit can be expected from the use of clonal-rooted trees in establishing and maintaining performance uniformity in an orchard in Massachusetts.

- 334 Abnormal behavior of newly set Oldenburg buds. By J. K. Shaw. *Amer. Soc. Hort. Sci. Proc.* 36(1938):126-128. 1939.

Of 150 buds set in August 1937, only about 30 percent grew normally. The others produced all sorts of abnormal flowerlike growths and various intergrades between flowers and shoots. Most of the abnormal growths later developed leafy shoots that grew into good one-year whips but were not so tall as those that started normally.

- 336 The effect of storage methods on ripening and quality of tomatoes. By Eleanor A. West and Grant B. Snyder. *Amer. Soc. Hort. Sci. Proc.* 36(1938):695-700. 1939.

The optimum length of storage, at temperatures of 45° to 50° F. and relative humidity of 45 percent, was between 20 and 30 days for firm ripe tomatoes and 30 days or more for green mature tomatoes. The latter developed a red color during storage. Shrinkage, including loss of weight and losses from disease, was least for green tomatoes. In the comparison of different methods of storage, shrinkage was least for fruit washed with formaldehyde and then protected against subsequent contamination.

- 337 Cereal flours as antioxidants in dairy products. By W. S. Mueller and M. J. Mack. *Food Research* 4(4):401-405. 1939.

Finely milled oat flour, whole oat flour, and corn flour had similar antioxidative properties when used in milk; but wheat, both whole and bleached, barley, rye, and rice flours had but little antioxidative value. Corn flour had antioxidative properties equal to those of oat flour when used in ice cream, and was somewhat more effective as a stabilizer.

- 338 Report on Zinc. By E. B. Holland and W. S. Ritchie. *Jour. Assoc. Off. Agr. Chem.* 22(2):333-338. 1939.

Work on the colorimetric method for the determination of zinc in food-stuffs was continued, with a modification of many details of the process and its expansion to permit the determination of both copper and lead when desired. The method, which is presented in detail, has given results sufficiently promising to warrant cooperative work on the part of the Association.

- 339 Vitamin C content of spinach. By C. F. Dunker and C. R. Fellers. *Amer. Soc. Hort. Sci. Proc.* 36(1938):500-504. 1939.

Fresh raw spinach contains from 400 to 450 international units of vitamin C per ounce. One third to two thirds of the ascorbic acid is lost

in cooking, depending on the amount of "cook water" used; in general the larger the amount of water the greater the loss. The canning of spinach causes loss of 60 to 65 percent of its vitamin C; freezing and incidental operations cause losses approximating 45 percent; dehydration results in total loss.

- 344 Equine encephalomyelitis virus (eastern type) isolated from ring-necked pheasant. By H. Van Roekel and Miriam K. Clarke. *Amer. Vet. Med. Assoc.* 94 (n. s. 47):466-468. 1939.

Equine encephalomyelitis virus (eastern type) was identified in pheasants submitted to this laboratory by the New Jersey Station. The English sparrow was shown by experimental inoculation to be susceptible to this virus and should be added to the list of hosts which may contract the disease.

- 346 Potatoes as carriers of vitamin C. By Mary E. Lyons and Carl R. Fellers. *Amer. Potato Jour.* 16(7):169-179. 1939.

Potatoes are a much cheaper source of vitamin C than either orange or tomato juice, and an ordinary serving will supply about one third of the daily requirement. The ascorbic acid content of potatoes was not significantly affected by geographical source, time of harvest, or size; but about half the original content was lost during ordinary home storage from December to May. About 40 percent of the ascorbic acid was lost in baking or boiling.

- 347 Effect of several calcium salts on the utilization of lactose. By Helen S. Mitchell, Gladys M. Cook, and Katherine L. O'Brien. *Jour. Nutrition* 18(4):319-327. 1939.

The addition of calcium salts to an adequate ration containing 60 percent lactose had little effect on the digestion of the lactose by rats, except in the case of calcium gluconate, which seemed to prevent most of the lactose from leaving the intestinal tract. The effect of sodium gluconate was even more pronounced. It would seem, therefore, that the gluconate radical in some way inhibits lactase activity.

- 348 Absence of linkage between genes for early sexual maturity and genes for high persistency in egg production in the domestic fowl. By F. A. Hays. *Proc. Seventh World's Poultry Congress and Exposition, Cleveland, Ohio.* 1939.

A study of 911 Rhode Island Red females showed that the apparent correlation between age at sexual maturity and length of biological laying year was spurious. The data further indicated independent inheritance of genes for early sexual maturity and genes for high persistency. No evidence appeared, however, against the expediency of selecting breeding stock on the basis of length of biological laying year.

- 355 Infectious avian encephalomyelitis. By H. Van Roekel, K. L. Bullis, and M. K. Clarke. *Jour. Amer. Vet. Med. Assoc.* 34:754-755. 1939.

This disease has made its appearance in many states, with the greatest incidence apparently in the northeastern states. Several of the breeds, both light and heavy, have been found susceptible. Under commercial practices the disease is transmissible among chicks through direct contact. The infective agent appears to be transmitted through the egg from the hen to its progeny. No reliable method of control has yet been worked out.

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Twenty years in two hours. By M. A. McKenzie. *Proc. of the 28th Ann. Meeting of the Mass. Tree Wardens' and Foresters' Assoc.* p. 20-22. 1939.



- Some factors to be considered in selecting chocolate-flavored milk. By W. S. Mueller. Contact vol. 2, no. 4, June 1939.
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- Factors affecting the vitamin C content of milk. By Myer Glickstein and J. H. Frandsen. The Milk Dealer, August 1939.
- New insect problems of Massachusetts fruit growers. By W. D. Whitcomb. Mass. Fruit Growers' Assoc. Ann. Rpt. 1939:156-164.
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MASSACHUSETTS;  
AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 378

FEBRUARY, 1941

# Annual Report

For the Fiscal Year Ending November 30, 1940

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The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

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MASSACHUSETTS STATE COLLEGE  
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# MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

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 YEGIAN, HRANT M., Agronomy

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# ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION — 1940

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## INTRODUCTION

F. J. Sievers, Director

Research, as first inaugurated in our agricultural experiment stations, had as its primary, if not its sole, objective a direct service to the farmer in the development of a more efficient production of agricultural products. While this objective appealed to the imagination of those delegated the responsibility of directing the activities of the experiment stations, its interpretation required modification so that the program of investigation could include also the problems of the farm home and, more recently, the problems of the entire consuming public where these problems were related to or influenced by the products of agriculture.

In the last several years, and especially during the period of depression when the nation was confronted with several paradoxical situations in its economy, it became evident that a critical evaluation of all public service agencies was in order. As a result of such a study the conclusion became self-evident that, while the problems over which the farmer could and might exercise control had been quite adequately served, there was not the same organized interest in serving the agricultural industry as a whole. With this study came a realization that the problems of the agricultural industry were not the concern of the farmer solely but were more especially a matter of public concern, and that some public agency was needed to give these problems emphatic and intelligent consideration. For this service the state agricultural experiment stations were naturally considered best qualified.

The acceptance of this responsibility, however, will affect not only the extent but more especially the nature of the work. By degrees, this change in service will be reflected in the projects which furnish a basis for these Annual Reports. Not only will experiment stations hereafter be required to furnish the technical or experimental evidence essential to the solution of problems of the farmer; they will need to become the source of that leadership which will keep the agricultural industry on a sound basis. The experiment stations should be relied upon to furnish the protection necessary to make sure that the practices developed on the farm in the interest of profit, or even of subsistence, are not operating to the detriment of the agricultural industry or the permanency of agricultural production, because it is recognized as unsound to depend upon the farmer in a matter of such wide general interest.

It is hoped that this report may contain some evidence that the Massachusetts Station is taking this new responsibility seriously.

## DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

**Enterprise Relationships and Farm Organization on Selected Farms in Massachusetts.** (C. R. Creek.)

*Costs and Returns of Growing Beans for Canning in Massachusetts.* Supervised records of costs and returns were kept by 22 of the 54 farmers who grew green and wax canning beans for the first time in 1940. Acreage was contracted with each grower and the price established at \$2.50 per hundredweight for grade A beans and \$1.00 per hundredweight for grade B. These 22 growers had 10.75 acres of wax and 30.9 acres of green pencil pod beans, which yielded 2371 pounds and 4528 pounds per acre, respectively. For all the farms that kept records, 82 percent of the wax beans and 80 percent of the green beans were grade A. Since price was determined entirely upon grade, the wax beans were delivered for \$2.227 and the green beans for \$2.196 per hundredweight or \$2.20 for all beans.

Cash costs included expense for seed, fertilizer, lime, dust material, rent, taxes, tractor and truck fuel, and hired labor for growing and harvesting. Family labor at 20 cents per hour and 20 cents per bushel for picking, and use of horses and machinery were added to these expenses to obtain total or farm costs for the enterprise. For all farms the cash cost was \$74.75 per acre, \$1.88 per hundredweight of beans, or 49 cents per bushel. The farm cost was \$83.70 per acre, \$2.11 per hundredweight and 55 cents per bushel. On 18 of these farms there was a net gain over cash costs, ranging from \$1.31 to six cents per hundredweight; but only nine farms showed a gain over total farm costs, which ranged from 70 to 10 cents per hundredweight. Two farms had very large losses in cash and farm costs because of high growing expenses and low yields.

The seven farms that had the lowest costs per hundredweight of beans had much greater yields of higher quality beans on a larger acreage than the seven farms with highest costs. Farm cost was \$1.84 and \$3.22 per hundredweight and cash costs \$1.75 and \$2.52 respectively for these two groups. The low-cost farms showed a gain of 37 cents per hundredweight or \$18.85 per acre over farm costs and 46 cents or \$23.20 gain over cash costs. The bean enterprise was a losing proposition on the seven high-cost farms, with a cash loss of 40 cents per hundredweight or \$8.50 per acre or a loss of \$1.10 per hundredweight or \$23.40 per acre when total farm costs were charged. Failure of the wax bean crop, low yields, and poor quality were the chief reasons for the losses on these farms.

Beans can be grown for canning in Massachusetts despite high labor and land costs if the farmer knows how to grow beans. The net return per acre will be smaller than in a year of good market prices, but a return is guaranteed by the contract if the beans can be grown for less than the established price. Commercial vegetable growers on large farms produced these beans for a profit in 1940 although many small growers lost money.

*Grass Silage on Massachusetts Dairy Farms.* The most common use of grass or hay silage in 1939 was to supplement summer pasture during the drouth in July and August. It was also used instead of green feed in the summer, as a supplement to corn silage in winter feeding, and in place of corn silage on some farms. Records on 72 farms throughout the state showed that 10,600 tons of molasses silage were made from 1477 acres of



various crops with a yield of 7.2 tons per acre. This silage was fed to 3994 cows at the annual rate of 2.6 tons per cow.

Mixed clover, alfalfa, and grasses were cut on 18.6 acres per farm for 31 farms to make 38 percent of the grass silage produced on these farms. Legume hay (clover and alfalfa) was cut on 23 of the farms with 14 acres each to make 22.5 percent of the total volume. Oats, wheat, rye, and barley were harvested green for silage on 37 farms with only 7.5 acres per farm to make 18.7 percent of the grass silage production. These small-grain crops were combined with vetch and peas, or millet and sudan grass with soybeans on 19 farms for 12.5 percent of the total tonnage from 9.5 acres per farm. Perennial grasses and millet and sudan were a small proportion of the entire crop although the yield of the two latter crops was highest at 8.5 tons per acre. Legume hay and mixed hay produced over seven tons of silage per acre, with some farmers obtaining as much as 10 tons.

Grass silage was made chiefly on institutional farms and the larger private dairies where special loaders and blowers could be purchased. On 15 farms both items were purchased at a total cost of \$600 while other farm operators bought cutters at \$425 or loaders at \$170. The special grass cutter and blower was considered by these dairymen to be more essential to efficient operation than the grass loader.

Most frequently mentioned advantage of grass silage was the fact that unfavorable weather caused no delay in putting up the crop. Milk production was maintained during the summer of 1939 by feeding grass silage, and some dairymen stated that production was increased over corn silage in winter feeding. Other points which were mentioned were less waste in coarse first cutting of grasses, higher quality hay from second crop, continuous use of land with a rotation of annual crops for grass silage, less expensive than green feed and more uniform distribution of labor during the summer when grass silage was produced.

Some disadvantages had to do with poor quality of feed because the grass was cut too late, and disagreeable odors from the molasses silage which were probably due to spoilage because insufficient molasses was used. Extra help and special equipment costs were other drawbacks.

*Vegetable Farming in Bristol County, Massachusetts, in 1939.* (Norman R. Urquhart—in cooperation with the Bureau of Agricultural Economics of the United States Department of Agriculture.) Cash expenses of growing vegetables and operating the farm business used up all the cash income from sales of produce and other sources on 22 commercial vegetable farms in Bristol County for the 1939 crop year. Low yields and low prices combined to make this one of the most unprofitable seasons in recent years. Adjustments in inventories and the charge for family labor produced a \$300 loss per farm in farm income. Interest on investment increased the loss to \$692 in labor income.

One-third of the farms that were the most profitable had a net cash return and farm income of more than \$1000 per farm and a labor income of \$485. However, the seven farms with greatest losses had cash expenses of \$1080 more than receipts. The acreage of vegetables per farm was almost equal in these two groups, but the yield of all crops was 16 percent larger and prices were 11 percent higher on the more profitable farms. Labor cost was higher per acre on the latter farms because of harvesting work, but labor return was 22 cents per hour compared to three cents on

the unprofitable farms. The average labor return for all farms was only 10 cents per hour. In 1939, the farms that made money produced several kinds of vegetables. This probably reduced the loss from the four or five very unprofitable crops in this area. Ten diversified farms with dairy and poultry enterprises in addition to vegetables and potatoes showed net returns that were much greater at \$1453 per farm. Of this, \$1157 was income from the livestock enterprises above feed and replacement costs.

The ten most important vegetable crops on the basis of total acreage on these commercial farms were sweet corn, tomatoes, iceberg lettuce, green beans, peppers, celery, spinach, cucumbers, cabbage and wax beans. These ten crops occupied 82 percent of the total acreage and accounted for 80 percent of total vegetable sales.

For the crop year 1939, 13 of the 22 commercial farms had greater cash incomes than cash expenses of operating the farms. Four farms had over \$1000 of net cash return which ranged from a high of \$2342 to a loss of \$4432 for all farms. On 10 farms, after family labor and depreciation were charged, the farm income was greater than expenses. Only six farm operators had a labor income as payment for their labor and management of the farm for the year.

Suggested farm plans for the reorganization of three low-income market garden farms have been prepared. Small fruits, strawberries and raspberries, have been substituted in the crop plan for the vegetables which were most unprofitable. A small poultry enterprise has been added to the farm business for the period from October through March to provide additional farm income. Plans were also made to increase the amount of family living from the farm through the crop and livestock enterprises.

These plans were made in an attempt to appraise the recommendations of the Rural Policy Committees on the basis of facts obtained in the economic analysis of these farms. The present crop and livestock systems were compared with the suggested systems to show the effects of the recommended changes in the choice and combination of enterprises. The plans cannot be evaluated here since they have not been entirely completed or approved.

**Labor Saving Methods and Techniques on Vegetable Farms.** (C. R. Creek and Richard Elliot.) Data were obtained on the time required to harvest and pack early iceberg lettuce on 10 farms in the Dighton area in June 1940. The most common method of harvesting consisted of two operations: cutting and trimming the heads; and packing into crates in the field. Each cutter usually took three rows, cutting all heads that were ready and placing them on the stump of the plant with the butt end up. Then the heads were packed into crates by other workers who followed the cutters. A crew of five men on one farm cut 22 crates (18 heads) of lettuce per hour per man. This lettuce was packed at the rate of 28 crates per hour for each packer.

In another system of harvesting lettuce two men cut and trimmed heads which were tossed to the packer who kept a crate nearby. Four crews of three men cut and packed 16 crates of lettuce per hour per worker. The fastest crew did 20 crates and the slowest did 13 crates per hour. A third system was used where one man cut and packed the heads in one operation. A small crew of two men cut and packed 17 crates each in an hour on poor cutting.

Packing-shed operations were of two types: one where the packed crates

were washed, paper and ice applied, and slats nailed on; and the repack system, where heads were packed into crates after being brought from the field in flat boxes. The most efficient packing-shed system was a line where packed crates were washed in a tub under a spray, removed to a table and ice applied, then pushed along and paper put on, after which the slats were nailed on the crates. In these operations on iceberg lettuce the work was done more efficiently where each man had a particular job to do or where the principle of division of labor was applied.

Methods and techniques in harvesting and packing tomatoes were studied in five market areas. Trellis tomatoes that were sold in baskets on the Boston market were picked and packed with less effort and in less time than the ground type of tomatoes in one-half boxes for the same market. In other areas trellis tomatoes were sold in bushel boxes, one-half boxes, and fruit baskets. Time required for packing varied greatly according to quality of the tomatoes, method of packing, layout of the packing shed and individual differences in workers. Here again, the "line system" was most efficient, the tomatoes being run out on an endless belt from the wiping machine and packed by workers stationed on both sides. Packing from boxes or from trays was generally slower and more tiresome than the "line system."

Celery harvesting in the field and packing shed operations were checked again in 1940. Many of the farm systems which were studied in 1939 have been rearranged and the celery was bunched and packed more rapidly this year. Harvesting and packing of carrots, cabbage, and cauliflower were studied on one or more farms to determine more efficient and easier methods.

**Competitive Factors Influencing the Supply of Market Milk and Cream in Massachusetts.** (A. A. Brown, J. Elizabeth Donley, and Mabelle Booth.) Attention during the past year has been devoted to refining the information on the density and location of production in the Springfield milkshed and preparing the manuscript for publication.

The shed was divided into fourteen areas or sections within which marketing characteristics were similar. Total production in these areas ranged from an average daily volume of 3,578 pounds to 18,136 pounds, a ratio of about 1:5. Since this difference might have been due to differences in the size of the areas, total production was reduced to pounds per square mile, or density of production. Here there was a range of from 34 to 180.9 pounds, with a ratio of 1:5.3 between the lowest and the highest density. This variation in density of production was attributed to variation in two factors: the density of farms (per 10 square miles) within the area and the average size of farm in each area. A correlation analysis showed that density of farms was about twice as significant as size of farm in explaining variation in density of production.

Simplified, the shed is made up of several geometric figures. The main area is a triangle with its base in northern Connecticut and its apex in Sunderland, Massachusetts. On the right side of the triangle is a square including the Gilbertville, Ware area. To the northwest is a non-adjoining broad arc-shaped belt. In addition to these sections is a rectangular one in southeastern Vermont and an irregular one just over the Massachusetts line in eastern New York.

The extremes in production were in the arc-shaped belt; to the lower left in the Berkshire Hills, deliveries per day per dairy were small, 125-



128 pounds; in the center and to the upper right they were relatively large, 226–287 pounds. Comparatively high production was characteristic also of the square on the right of the triangle, 220–224 pounds. A scale of production, intermediate to the extremes, was characteristic of the belt contiguous to and surrounding the market, 190–214 pounds. Production in the angles of the triangle tended to average about the same and was moderately light, 162–169 pounds.

**An Analysis of Selected Merchandising Practices in the Fruit and Vegetable Industry.** (A. A. Brown, Sargent Russell, and Mabelle Booth.) A study of apple prices on Washington Street Wholesale Market was made for 1934–35 and 1935–36. In studying the relationships between various factors which supposedly affect wholesale apple prices in New York City, no significant relationship was found other than that which existed because of normal seasonal variations of the factors. Stating it another way, when the normal seasonal variation was removed from the factors which affected price, no further relationships existed. The factors studied were temperature, weather (precipitation and degree of cloudiness), receipts (total as reported by Market News Service), and sales (figures for two companies from which records were obtained).

Correlations between price and temperature, weather, receipts, and sales without the removal of seasonal variation, were:

Temperature .....	.7427
Weather .....	.4284
(0 was clear)	
(10 cloudy or rain)	
Receipts .....	.8023
Sales .....	.6026

An investigation was also begun on the Cambridge Regional Produce Market. A study of this cooperative farmers' market was undertaken to determine the extent to which it has failed to come up to expectations; and the causes for such failure.

The degree of failure depends on the measure used. Certainly if one uses the regularity with which the market corporation has paid the interest on its obligations, the undertaking has failed 100 percent. If one uses the number of wholesalers and jobbers who have moved from the old market districts to the new as a measure of failure, the result is also 100 percent. If the degree of patronage by so-called large buyers—the chain stores and out-of-town jobbers—is the measure, the extent of failure is still complete. These premises were, however, the original ones upon which success was supposed to depend. In addition to them, of course, was farm patronage and in this quarter there has been both failure and success, and the achievements are all the more remarkable. Complete records during the first five years of the market are not yet available.

During the 1940 season for July 1 to October 25, inclusive, a period of 82 market days, 548 different farmers used the Cambridge Regional Produce Market. Only 36 of the total, however, were on the market for more than half the entire season. Equally extreme was the appearance of 183 users who sold on the market but once.

A preliminary analysis indicates that the majority of market users were small-scale farmers. They accounted for approximately 75 to 95 percent of the sellers on any one day, and had fifty packages on the load.

At the peak of the season on September 20, 140 farmers' trucks were on the market. The low point was on July 16 with 17 trucks. The market was most heavily patronized on Friday night, with the other days of the week in the following order: Monday, Wednesday, Thursday, and Tuesday.

## DEPARTMENT OF AGRONOMY

Walter S. Eisenmenger in Charge

**Tobacco Projects.** (Walter S. Eisenmenger and Karol J. Kucinski.) It has been found that when plants of high lignin content are grown during the year preceding tobacco, the succeeding crop of tobacco is more likely to be affected by the so-called brown root-rot. The ligneous material, instead of being itself a specific cause of trouble, apparently encourages a class of decomposing organisms which are conducive to injury of the crop.

With the maturity of any seed plant the lignin content increases. During the past two years twelve different crops were sown at three different periods at about four-week intervals. The earliest plantings of these crops were completely ripe; the second, less ripe; and the third, still in the succulent stage when freezing weather came.

When tobacco was grown the following year on these variously treated plots, it was apparent that the tobacco grown after the completely mature crop was inferior to tobacco grown after the less mature crop, and the tobacco grown after the most immature plants was the best.

In another phase of this investigation tobacco was grown following a large number of plants. These various crops arrange themselves in the following descending order based upon the three-year average of the crop index of tobacco grown in rotation with them: sea weed (application), squash, horseweed, red top, ragweed, Jerusalem artichoke, gladiolus, carrots, sweet clover, buckwheat, cabbage, turnip, wheat, tomatoes, rye, Kentucky blue grass, millet, orchard grass, alfalfa, peppers, Sudan grass, sorghum, and red clover. In general the various crops ranked about as in other years in their effect upon yield and quality of tobacco.

**The Lignin and Methoxy Content of Some Common Crops.** (Walter S. Eisenmenger and John W. Hurdis.) It has been known for a long time that during the active period of decomposition of plant tissue containing large percentages of lignin, a retardation of growth and subsequent economic loss result with some crops. This presence of large quantities of lignin seems to interfere rather seriously with the tobacco crop.

Twelve different plants were chosen for study: Jerusalem artichoke, barley, buckwheat, corn, millet, oats, rape, rye, sorghum, Sudan grass, timothy, and tobacco. Samples were harvested at three different periods of maturity: first, when the crops were in a stage of rapid vegetative growth; second, when they were nearing maturity, being in the dough stage of seed development; and third, when they were mature.

As the plants approached maturity, there was an increasing carbon content, which, in conjunction with a decrease of total nitrogen, brought about a widening of the carbon-nitrogen ratio. With maturity, an increase in the methoxy content of the plants and in the methoxy content of lignin accompanied their increasing lignin content, while the total ex-

tractives and ash decreased. Those components which are most resistant to the action of bacteria and fungi are the ones which increase with maturity.

When tobacco followed these plants, the yields were lowest, both in quantity and quality, on those plots where the preceding crop had been allowed to mature.

**The Absorption by Food Plants of Chemical Elements Important in Human Nutrition.** (Walter S. Eisenmenger and Karol J. Kucinski.) If certain chemical elements are added to the soil in abundance, they are taken in by some kinds of plants in amounts larger than the normal growth and metabolism of the plants require. This is sometimes referred to as "luxury consumption" of elements. Other elements, however, are taken into the plants only in amounts needed. In this experiment, lettuce and cabbage were grown on a soil to which the cations, sodium, potassium, magnesium, and calcium, and the anions, chlorine, iodine, bromine, sulfate, and phosphate, were added separately to plots in quantities known to be far in excess of normal plant requirements, but not in sufficient quantity to be toxic.

The analyses show that the intake of all cations was substantially increased and that the increases of magnesium and potassium were greater than those of calcium and sodium. Thus, magnesium and potassium are much more nearly in the "luxury consumption" class than either calcium or sodium.

Phosphorus was increased in the roots about twice as much as in the tops, while the greatest increase of bromine and iodine was in the tops. Bromine and chlorine showed the highest percentage increases of any of the elements studied. Sulfur was increased substantially in both tops and roots of lettuce but not in cabbage. Cabbage is noted for its sulfur content; but sulfur is not a "luxury consumption" element, and the cabbage takes in only its normal amount regardless of the presence of an excess of the element in the soil.

**The Intake by Plants of Elements Applied to the Soil in Pairs Compared to the Intake of the Same Elements Applied Singly.** (Walter S. Eisenmenger and Karol J. Kucinski.) Results of other experiments have shown that the application of elements to soil tends to increase their quantity in the plant. In this experiment it was decided to study the intake by plants of elements added two at a time to the soil in quantities known to be excessive but not toxic. The materials used supplied calcium, potassium, and sodium at the rate of 250 parts per million of soil, and lithium at the rate of 100 parts per million. Lithium is exceedingly toxic; therefore it was added several months before seeding.

This study is in its initial stages, but analysis of cabbage, celery, and lettuce plants indicates that when sodium and calcium salts were applied together to soil, the calcium intake of the plants decreased. Similar results were obtained when potassium was added with calcium, but the percentage intake of potassium increased. Plants can tolerate lithium only in small quantities; but when potassium and lithium were added together to the soil, the intake of lithium was decreased. When cabbage plants were grown in soil treated with both potassium and sodium, the potassium intake was definitely decreased, which indicates that sodium can apparently replace potassium in plant nutrition.



**Magnesium Requirements of Plants.** (Walter S. Eisenmenger and Karol J. Kucinski.) Various species of plants have been grown on an area known to be deficient in magnesium. On the basis of foliar observation in the field it has been possible to separate the different species into two groups according to their apparent tolerance to magnesium deficiency. This classification is as follows:

<i>Tolerant</i>		<i>Not Tolerant</i>	
Alfalfa	Millet	Buckwheat	Pumpkins
Apple	Peas	Cabbage	Radish
Asparagus	Rhubarb	Cauliflower	Rape
Beans	Rye	Corn	Rutabagas
Beets	Soybeans	Cucumber	Spinach
Blueberries	Strawberries	Eggplant	Squash
Carrots	Sudan Grass	Grapes	Sunflower
Gladiolus	Sweet Potatoes	Mangels	Tobacco
Hollyhocks	Swiss Chard	Muskmelons	Tomatoes
Lettuce		Okra	Turnip
		Peaches	Velvet Leaf ( <i>Abutilon avicennae</i> )
		Peppers	
		Potatoes	Watermelon

Chemical analyses of the various plants have shown that when only magnesium was added to the soil all plants increased in magnesium, while their calcium content was generally decreased. Experience has shown that magnesium is more easily introduced into plant tissue than calcium when additional amounts are added to soil. When magnesium and calcium are added to the soil together, the intake of both elements may be decreased.

Calcium applications hastened the maturity of certain cucurbits. Determination of sugar in raspberries showed that magnesium applications tended to increase the sugar content while application of both magnesium and calcium produced raspberries with the highest sugar content.

**The Relative Toxicity of Certain Ions and the Function of the Calcium Ion as an Antagonist as Indicated by Soybean Roots.** (Walter S. Eisenmenger and Plese Corbett.) It has been recognized in agricultural practice that elements used to stimulate plant growth or as fungicides and insecticides may leave residues in the soil which tend to act as poisons to the plants if applied in sufficiently large quantities. However, if these same elements are applied in moderate quantities, they may be beneficial.

Seedlings were grown in single salt solutions of calcium nitrate, copper sulfate, lithium carbonate, manganese sulfate, magnesium sulfate, and zinc sulfate. Since the anions of these salts have been found not to influence growth to any appreciable extent, the cations are the factors to be considered. Each of the cations,  $\text{Ca}^{++}$ ,  $\text{Cu}^{++}$ ,  $\text{Li}^{+}$ ,  $\text{Mg}^{++}$ ,  $\text{Mn}^{++}$  and  $\text{Zn}^{++}$ , was found to be toxic in single salt solution; but the calcium ion in the form of  $\text{Ca}(\text{NO}_3)_2$  when placed with any one of the other single salt solutions overcame the toxicity of the medium to soybean seedlings. Over wide ranges of concentrations, the mixed solutions were less toxic than any of the single ion solutions.

**The Effect of the Calcium Ion on the Development of Soybean Seedlings and the Antagonism of This Ion to Arsenic, Boron, and Selenium Ions.** (Walter S. Eisenmenger and Elvin T. Miles.) Farmers in certain regions have in recent years suffered partial loss of their crop because of relative scarcity of boron in the soil. This deficiency of boron was seemingly augmented by the addition of lime to the soil. It seems that when small amounts of boron are used on the soil to produce more normal plant growth the application of calcium will reduce the efficiency of the boron. This action of lime is not unlike that experienced when the calcium is used to overcome the toxic effect of overdoses of boron. Also in certain sections of the country the residues of arsenic from applications of sprays over a long period of time have been found to retard subsequent growth of annuals.

In an experiment designed to show growth of seedlings of soybeans in single salt solutions of boron, arsenic, and selenium, it was found that 1 p.p.m. of arsenic, 1.5 p.p.m. of boron, or 4 p.p.m. of selenium in aqueous solution produced a toxic reaction. In the presence of a neutral calcium salt, however, arsenic produced toxic effects only when the arsenic was present at the rate of 2 p.p.m. The toxic action of boron and selenium was also depressed by the presence of a neutral calcium salt. On the other hand it also holds true that the ions of arsenic, boron, and selenium will counteract the toxic action of single salt solutions of neutral calcium ions.

**The Effect of Arsenious, Arsenic, and Antimony Oxides on Soil and Plant Growth.** (Walter S. Eisenmenger and Hrant M. Yegian.) Pot culture studies under greenhouse conditions on the effect of arsenious, arsenic, and antimony oxides on Merrimac fine sandy loam and subsequent crop growth are being continued. Five successive crops, barley and buckwheat alternating, have been grown in the same pots during 1939 and 1940, and the lightest applications of arsenious and arsenic oxides (500 p.p.m. and 250 p.p.m. respectively) are still toxic to barley, and 1500 p.p.m. of arsenious oxide and 2,000 p. p. m. of arsenic oxide are toxic to buckwheat.

It was found that by returning sufficient amounts of buckwheat and barley tops to the pots arsenic toxicity could be overcome. A photograph of the fifth crop, buckwheat, grown in pots treated with arsenious oxide shows the value of organic matter in overcoming the arsenic toxicity very clearly. (Page 57.)

The antimony oxide treatment did not affect the yields of barley or buckwheat, and the soil was not injured even temporarily by the heaviest application (2000 p.p.m. antimony oxide).

**Sunflowers and Their Possibilities.** (Karol J. Kucinski and Walter S. Eisenmenger.) After the encouraging results obtained last year, the experiment was continued. Although the season was exceptionally late this year, sunflowers were planted on the 15th of May and grew to maturity, forming exceptionally large seed heads.

From the standpoint of seed production, fertilizer tests with sunflowers show that apparently they are not very heavy feeders. Doubling the application of fertilizer increased the yield of seed only about 5 percent. The best plots yielded about one ton of good seed to the acre. Seedlings of one seed per hill every 18 inches in 36-inch rows proved to be better than two seeds per hill in 36-inch check rows. Two seeds per hill 18

inches apart produced very thin, weak plants which lodged so badly after wind storms that the crop was almost a complete failure. The two pictures on page 56 show comparative results obtained with the two systems of planting.

When sunflower plants were used for silage, as high as 19 tons per acre were obtained, comparing favorably with the yield of corn. If the sunflower plants were ensiled while their leaves and stalks were still green, cattle seemed to relish the silage and thrive on it.

**Soil Conservation Research Projects.** (Karol J. Kucinski and Walter S. Eisenmenger.)

*A Survey of Erosion Problems Arising from Changes in Land Use.* During the past year a detailed study has been made to find out whether the increasing potato acreage in Massachusetts has encouraged soil erosion problems. Many acres of old sod and pasture land have been plowed under within the past two or three years. Most of this new potato land is located on the sloping hillsides in the western part of Massachusetts. It is quite evident that this change in land use is resulting in the rapid decomposition of soil organic matter which has been accumulating for the past generation. The soil is exceptionally fertile at present and lends itself to large-scale field operations. If the potato crop is harvested very late in the fall and no cover crop is used, the soil erodes very readily with an appreciable loss of topsoil. It is felt by some that if this soil erosion is permitted to go on without any precautionary measures being taken for its prevention, the present high yields of potatoes cannot be maintained because of loss of organic matter and fertility of the top soil. It is deemed advisable, therefore, to encourage potato growers to practice soil conservation methods such as winter cover cropping and terrace and contour farming of their hillsides.

*The Relation between the Rate of Wind Erosion and the Principal Factors Affecting it.* In one phase of this investigation a detailed study was made of the wind erosion at the Cape. The sand areas found at the extremity of Cape Cod are approximately 6,000 acres in extent. Most of these areas, and especially those enclosing Provincetown Harbor, were originally forested but have been extensively devastated within historic time. As far back as 1714, and especially in 1826, extensive reclamation programs were initiated to stabilize these sand areas at the Province Lands. These early attempts were not too successful because woody plants were planted in the shifting sand without any previous introduction of beach grass to prevent the sand from moving away from the newly planted trees.

Today, various methods are used with great success in controlling the shifting sands and establishing permanent vegetative cover over the dunes. On very active sand dunes, branches of native pine are spread on the northwest side of the dune covering the "blow side" or "live side" of the dune. These branches act as a barrier which reduces the velocity of the wind and a shelter which catches beach grass seed. This beach grass seed, which is plentiful, germinates and the grass starts to establish itself during the next season. Not until the beach grass is well established is it desirable to make any tree plantings. Usually after two or three years the beach grass will spread itself sufficiently over the sand to prevent any further occurrence of serious "blow outs." When this stage has been reached, pine trees can be planted safely. It is the common practice to



plant in the early spring when there is plenty of moisture in the sand three- to five-year-old pine trees in rows about three feet apart in either direction. Various species, such as *Pinus sylvestris*, *P. mughus*, *P. austriaca*, and *P. rigida*, have been used effectively in establishing permanent cover over the dunes. The Austrian pine has been found preferable to the Scotch pine (*P. sylvestris*) for this region, since it seems to withstand the cold winters experienced at the Cape better than any other tree that has been tried.

In certain localities where the wind tends to blow out the embankments of roads it is expedient to sod with hog cranberry or beach grass a continuous strip two or three feet wide, parallel to the edge of the road. In some instances it has been found practical to spread a thick layer of native grass hay on the active wind-blown road embankments. This acts as a protective mulch for germinating the seed that is present in the hay or that is blown in.

Seeds of such native plants as sand peas, sumac, and Scotch broom, when sown broadcast on the sand in places where the wind is not too severe, germinate and produce a very desirable cover. To a lesser extent transplantation of bayberry shrubs can be useful in forming a protective marginal planting and windbreak where the wind has started to expose roots of previously planted trees. On the other hand, the beach plum, which is quite common, should not be encouraged since it is a host to many insects which are harmful to the more desirable types of trees.

The photograph on page 57, taken at Wellfleet, shows the characteristic way in which hog cranberry is adapted for controlling slope erosion on the sandy hills and roadside embankments at Cape Cod.

**Trials with Improved Strains of Hay and Pasture Species.** (W. G. Colby.) Nursery trials and small-plot experiments carried on for the last three years with several hundred strains of grasses and legumes indicate that some of these strains have definite merit and should be given wider trials over the state. Included in this group of superior plants are strains of Timothy, Orchard Grass, Meadow Fescue, Perennial Ryegrass, and Medium Red Clover.

*Timothy.* The following selections obtained from Professor Morgan W. Evans at Wooster, Ohio, gave superior performance:

F. C. 11,901: This is a very early-maturing strain, vigorous in growth, moderately leafy, and producing a good aftermath growth if weather conditions are favorable. It reaches the "bloom" stage about the 20th of June.

F. C. 15,167: This selection matures about a month later than F. C. 11,901. It is a dark green, leafy strain which produces a good yield of hay but not much aftermath.

*Orchard Grass.* The aggressive growth habits of orchard grass together with its early maturity have been some of the undesirable features which have hindered its more general use. The following improved strains have overcome, to some extent at least, some of these undesirable features.

Aberystwyth S. 37: This is a very leafy strain which produces a dense vigorous growth. Relatively few seed stalks are produced and these reach maturity about ten days later than the seed stalks of commercial strains of orchard grass. The use of this strain both in hay and pasture mixtures seems promising.

**Finnish Commercial:** A strain of orchard grass obtained from a com-

mercial seedsman in Finland shows promise as a hay type. It does not grow as tall as native commercial strains but it produces a dense, dark green growth, is much more leafy, and matures a week later.

*Meadow Fescue.* Svalöf's Early Meadow Fescue has been the most promising strain of this species. Although a little earlier than is desirable, this strain is the only one tested which thus far has shown a complete immunity to leaf rust. During the 1940 season the rust infestation on all other strains was severe and seriously affected the yield.

*Perennial Ryegrass.* Although perennial ryegrass may never become an important hay or pasture grass in Massachusetts, several of the strains tested were superior to those now available commercially. The strain O.A.C. No. 1 from Dr. McConkey at Guelph, Canada, and the strain E. F. 79 and Otofte from Denmark should be included in this group.

*Red Clover.* Of the many strains of medium red clover tested, three obtained from Dr. E. A. Hollowell of the U. S. D. A. grew particularly well. These were F. C. 22,655 (Central Corn Belt Blend), F. C. 22,586 (Illinois Red Clover), and F. C. 30,124 (Indiana Red Clover). A number of strains of foreign origin made a vigorous initial growth and suffered no winter injury but were severely attacked by leafhoppers. For this reason alone it was necessary to discard practically all strains of foreign origin.

**Ryegrasses as Green Manure Crops.** (Hrant M. Yegian and W. G. Colby.) The relative value of three varieties of ryegrass as green manure and winter cover crops following onions is being studied. The species which have been grown are briefly described as follows:

*Domestic ryegrass* (*Lolium sp.*) is a moderately winter-hardy species which is already being used as a cover crop by many vegetable growers. From 50 to 60 percent of the plants will survive the average winter; so unless the crop is completely turned under in the plowing operation, volunteer plants may interfere with the cultivation of the subsequent crop. If planted by the middle of August and plowed under by the first of October, from three-fourths of a ton to a ton and half of dry matter can be expected in the tops, depending upon the amount of available moisture and plant nutrients during this growing period. The tops together with the roots, therefore, add a considerable amount of organic matter to the soil.

*Westerwolds ryegrass* (*L. annum var. westerwoldium*) differs from ordinary domestic ryegrass in its strictly annual growth. It will produce about the same amount of growth as domestic ryegrass if planted by the first or middle of August. Being completely winterkilled, it will not produce any voluntary growth in the spring or interfere with subsequent crop cultivation.

*Lolium subulatum*, known as *Wimmera ryegrass* in Australia, is also an annual. It does not appear to develop as rapidly as the Westerwolds ryegrass, but the difference in growth is not great and it can be substituted for Westerwolds if the need arises.

The value of these ryegrasses as a green manure or winter cover crop depends to a large extent upon the nature of the soil and the weather conditions. One of these grasses, seeded at the rate of 30 to 35 pounds to the acre by the middle of August on land moderately high in fertility, with a moderate supply of rainfall, will produce a dense vegetative cover, and a considerable quantity of organic matter will be added to the soil.

**Potato Variety Trials.** (Ralph W. Donaldson, Walter S. Eisenmenger, and Karol J. Kucinski.) Based on yields, the ranking of potato varieties grown in plots at the college during the season of 1940 was Houma, Sequoia, Green Mountain, Sebago, Russet Rural, Earlane No. 2, Chipewawa, Irish Cobbler, Warba, Katahdin, and Mesaba. The average yield of all varieties mentioned was 50 percent more on plots sprayed twelve times than on plots sprayed only twice.

**Downward Movement of Lime in Pasture Soils.** (Arthur B. Beaumont.) In the spring of 1924 lime was applied as topdressing in two rates to certain plots used in a pasture experiment. In the fall of 1940, 16½ years later, samples of soil from these plots were tested for reaction. The results are as follows:

Depth at Which Sample Was Taken	Soil Reaction (pH) 16½ Years after Application of Limestone		
	No Lime	3480 lb. per Acre	10360 lb. per Acre
Inches			
0 - 4	4.5	5.6	6.9
4 - 8	4.7	5.1	6.6
8 - 12	4.7	5.3	6.0
12 - 16	5.1	5.6	5.6
16 - 20	5.3	5.6	6.1
20 - 24	5.5	5.8	5.9

**The Effect of Fineness of Limestone on Soil Reaction.** (Ralph W. Donaldson, Walter S. Eisenmenger, and Hrant M. Yegian.) How soon does liming become effective in sweetening soil and how do commercial lime products of varying fineness compare in this respect? These points are frequently raised by farmers and by lime manufacturers.

A preliminary study has been in progress eight months to observe what changes in pH are produced under a laboratory setup where commercial limes of differing fineness are applied to soil and results measured at frequent intervals by means of a Beckman glass electrode meter. Both limed and unlimed samples were kept in glass jars and maintained at optimum moisture conditions, with no plants being grown.

Five commercial grades of limestone, ranging from coarsely ground (50% through 60-mesh) to moderately finely pulverized (95% through 60-mesh), and one hydrated lime were thoroughly mixed with dry soil to furnish equivalent oxides and applied in three different rates—1½, 3, and 6 tons of (equivalent) limestone to the acre. These limes were compared on two Becket loams; one of initial pH 5.4 and the other a forest podzol of pH 3.6. Results obtained so far indicate:

1. With one soil (podzol), the sweetening effect of each lime was immediate and greatest at the first 10-day period of sampling. This condition remained fairly constant for about three months, after which differences between limed samples and the unlimed check decreased considerably.

With the other (less acid) soil, the initial change in pH induced by liming was also great; but after two months, in contrast with the other soil, differences between limed samples and the unlimed check tended in some cases to increase.

2. The finest lime (hydrated) produced the greatest change and the coarsest grade of limestone produced the least change in soil reaction. This distinction was measurable and consistent for these materials applied at all three rates and on both soils.



As would be expected, the three limestones of intermediate fineness produced changes of reaction between the two extremes. No consistent difference in effect was apparent between these intermediate grades except on one soil when they were applied at the 6-ton rate; then slight differences in soil reaction due to relative fineness of these limes became apparent.

3. Subsequent determinations made after an eight-month interval revealed varying rates of nitrate formation and accumulation, which increased the soil acidity. This was most pronounced where the finest limes had been applied, but occurred also to a marked extent in the check soil of initial pH 5.4 which at the end of the eight months had dropped to pH 4.3. If the nitrates had been removed from the soil solution by growing plants, the results might have presented a slightly truer picture of the effect of fineness of lime material in changing soil reaction.

**Borax Trials on Alfalfa.** (Ralph W. Donaldson, Walter S. Eisenmenger, and William G. Colby.) Borax, topdressed on 16 alfalfa stands in the state, and applied during November 1939 in strips at the rate of 25 pounds to the acre, controlled alfalfa yellowing on fields where it appeared after removal of the first crop of 1940. No yellowing was apparent in the early-season growth of the crop.

A yellowing of terminal leaflets, occasional bronzing, and more or less stunting developed on maturing plants of both the second and third growth of alfalfa located on approximately half the fields included in this investigation. These symptoms did not appear on the borax-treated strips, on which the plants stood out in contrast, showing better growth and normal color. These symptoms of boron deficiency did not develop during the early season when the rainfall was high but were associated apparently with the drier period of insufficient rainfall and later drought conditions prevailing until autumn frosts. Moreover, those fields which showed symptoms of boron deficiency were found to be predominantly those located on soils of the lighter texture (Merrimac). Little or no evidence of response to borax was observed this season on alfalfa located mostly on heavier soils, presumed to be of higher moisture content.

Symptoms of boron deficiency developed on plots of alfalfa which had received muriate of potash, 300 pounds to the acre, for three consecutive years. Since an application of borax corrected this trouble, it follows that muriate of potash in the amount applied did not correct a condition of boron deficiency in this case.

When borax (20, 30, 50, and 50 pounds to the acre) was applied in July at the time of seeding alfalfa and Ladino clover, temporary leaf injury and stunting of seedlings of both the legumes and weeds resulted at rates above 30 pounds to the acre. However, no injurious effect was observed the following season in character of stand or of growth from any rates of the borax applied. The soil was of limestone origin with pH around the neutral point.

## COOPERATIVE TOBACCO INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture in Cooperation with the Massachusetts Agricultural Experiment Station.

C. V. Kightlinger, U. S. D. A., in Charge

**Black Root-Rot.** (C. V. Kightlinger.) Black root-rot is one of the most important diseases of tobacco in the Connecticut Valley. The project to develop new strains of Havana Seed which are more resistant to black root-rot and acceptable in type, yield and quality in the Connecticut Valley, is consequently being continued.

Selections from Havana No. 211 have been made to improve the strain. New strains have been produced by crossing strains of Havana Seed that are resistant to black root-rot with strains of common Havana Seed that are highly approved for type and quality. Selections from the progeny of these new strains and their back-crosses are being tested.

**Soil Treatments for Tobacco Seedbeds.** (C. V. Kightlinger.) Damping-off diseases and weeds in tobacco seedbeds are important in tobacco growing in the Connecticut Valley. Treatments to control these troubles are consequently important.

Most of the large tobacco growers in the Connecticut Valley steam sterilize their seedbeds in the fall; a few steam treat their seedbeds in the spring. The practice of sterilizing tobacco seedbeds, however, is not so general in the Connecticut Valley as it should be. It is probable that more growers would sterilize their seedbeds if steaming equipment were not so expensive, or if other recommended methods did not cause inconvenience in application and delay in seeding. A method other than steam sterilization which would be effective, cheap, and convenient to use in controlling damping-off diseases and weeds in seedbeds, would mean much to the tobacco growing business in the Connecticut Valley.

Seedbeds which have been steam sterilized in the fall sometimes develop damping-off troubles because of subsequent contamination. Carelessness on the part of men working around the seedbeds may cause a large part of the contamination; but wind-blown earth, which is fairly common in the Connecticut Valley during the winter and spring of most years, is responsible for a considerable part of the contamination. Supplementary spring treatments for seedbeds steam sterilized in the fall, which would be effective against damping off, cheap, and convenient, would be a valuable aid.

Experiments were begun in the fall of 1940 to test the effectiveness of certain other treatments in comparison with steam sterilization, to control damping-off diseases and to kill weeds in tobacco seedbeds. The experiments include both fall and spring treatments. Preparation for the test was begun a year earlier by maintaining a seedbed to which earth infested with damping-off organisms obtained from seedbeds in various places in the Connecticut Valley, was applied during the spring and summer, to assure the presence of various types of damping-off organisms. Tobacco seedlings were grown from time to time in the seedbed throughout the spring and summer to increase the supply of damping-off organisms. Damping-off of tobacco seedlings was occurring in this seedbed when the soil was worked to prepare it for fall treatments of the experiment.

**Overwintering of Common Tobacco Mosaic Virus in Soil Under Natural Conditions.** (C. V. Kightlinger.) This project has been completed. The purpose was to determine whether common tobacco mosaic virus could overwinter in soil under natural conditions in the Connecticut Valley, and if so, then to determine how much mosaic would develop in succeeding tobacco crops with the overwintered virus as a source of inoculum. By way of summary of experimental results, it may be stated that the mosaic virus overwintered abundantly in the soil but that only a small percentage of the tobacco plants grown on the land developed mosaic.

## DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in charge

**The Effect of Complex Mineral and Vitamin Mixtures on Milk Production, General Health, and Reproductive Efficiency in Dairy Cattle.** (J. G. Archibald.) This project was completed during the past year. A confidential report was furnished to all interested parties, but release of the results in a general publication is not contemplated. No benefits from the feeding of two of the three complex mixtures investigated over a two-year period, were in evidence. Slight positive results were obtained from the third supplement fed. The following paragraphs are quoted from the confidential report on this particular supplement:

Although only one, or possibly two, of the differences between the groups of cows are of significance, nevertheless the general trend of the evidence slightly favors the group which received the supplement. These cows maintained their general condition slightly better than the controls did; they gave slightly more milk (1.4 lbs. daily); they required a significantly smaller number of services to get them with calf; and they had somewhat less trouble at calving time with retained afterbirth.

It is impossible, of course, to say definitely whether the supplement as a whole produced this desirable effect, or whether it was due to some one ingredient of what was a rather complex proprietary mixture, and, if the latter, what particular ingredient. It is our opinion, however, that the ingredient most likely to have been responsible for the slight benefits noticed was the cod liver oil the supplement contained. Results of a somewhat similar magnitude and trend were obtained a few years ago in an extensive trial of the merits of a cod liver oil concentrate added to the grain mixture for about half the milking herd of cows at the Massachusetts State College.

It seems probable that the price of the supplement (9 cents a pound at the time it was purchased in 1936) would prohibit its use by the average farmer. Fed at the rate of two percent of the grain mixture, it would add \$3.60 to the cost of each ton of mixed grain. If, as we believe, the beneficial effect of the supplement is due to the cod liver oil it contains, sufficient cod liver oil concentrate to furnish 30,000 additional U. S. P. units of vitamin A per cow daily (an amount that along with the potential vitamin A in average quality roughage provides a reasonable margin over requirements) can be purchased for not more than \$1.00 of additional cost per ton of mixed grain.

**A Study of the Mineral Elements of Cow's Milk.** (J. G. Archibald and C. H. Parsons.) For reasons outlined in last year's report, the work



with iron in milk was repeated during the winter of 1939-40. In the earlier work done in 1938-39 only about as much supplemental iron was fed daily as calculation showed to be already present in the ration. In this more recent work from 3 to 4 times as much iron was added as occurred naturally in the ration; as before, the supplement was the readily soluble iron ammonium citrate.

Results were very variable, with no definite trend. Average amounts of iron were of the order of 0.3 mg. per kilo of milk or less, somewhat less than was found in the earlier work, due it is thought to refinements in method. As before, differences between individual cows in the same group or between samples from the same cow in different months were much greater than the average differences between the group receiving iron and the group that did not receive it. Irrespective of method of statistical handling of the results these average group differences were not significant. It is therefore concluded that the iron content of cows' milk cannot be consistently changed by feeding an iron supplement. Workers in other experiment stations have reached this same conclusion but with smaller numbers of cows and over shorter periods of time. The element manganese is being studied this year.

**Investigation of the Merits of Legume and Grass Silage for Massachusetts Agriculture.** (J. G. Archibald and C. H. Parsons.) Further work was done with phosphoric acid silage during the winter of 1939-40. In double reversal feeding trials with fourteen cows over a period of 3½ months, practically the same amount of milk was produced on this type of silage as on corn silage (39.30 lbs. daily per cow as contrasted with 39.35 lbs. daily per cow). However, the observations in last year's report regarding palatability and gains in live weight have been confirmed. Phosphoric acid silage was somewhat less palatable to cows than either corn silage or molasses silage, and gains in live weight were practically negligible when it was fed. Again this year phosphoric acid silage has produced milk of a finer flavor than that from cows on corn silage.

Our first extensive trial of the suitability of molasses grass silage for growing dairy heifers was made during the past winter in comparison with corn silage. In a double reversal trial 12 weeks in length, 18 heifers gained 7.3 percent in live weight when fed corn silage, and 6.3 percent when fed molasses grass silage. Average grade for condition, based on general appearance and handling was:

On corn .....	Good + + + +
On grass .....	Good +

The molasses silage was readily eaten by the heifers.

Results of this trial coupled with small weight gains noted when this type of silage is fed to milking cows lead us to the tentative conclusion that grass silage is better suited to milk production than to laying on of flesh.

**A study of Urea as a Partial Substitute for Protein in the Ration of Dairy Cows.** (J. G. Archibald.) This project was organized the first of the year in cooperation with the E. I. DuPont de Nemours Company of Wilmington, Delaware, and the Massachusetts State Department of Mental Health. Twenty-four cows in the herd of the Medfield State Hospital are included in the feeding trial, eight of them on a double reversal plan with periods eight weeks in length, and the other sixteen on a continuous feeding plan, eight to receive the regular herd ration for two

complete lactations while the other eight receive a grain mixture in which urea has been substituted for the usual protein concentrates (cottonseed meal, soy bean oil meal, and gluten feed). The maximum amount of urea which it is planned to feed is 3 percent of the grain allowance (60 lbs. per ton). This amount has now been fed for over six months without untoward results. Cornstarch is being used to balance the energy content of the grain mixture which contains urea.

The first season's work with the eight cows on the double reversal experiment has been completed and summarized, and results from the first twenty-two weeks with the sixteen cows on the continuous feeding trial are also available. While final conclusions must await the outcome of another year's work, results to date indicate that, except for a slight superiority in the general condition of the cows receiving the regular ration, the two rations have had apparently similar effects.

**The Effect of Feeding Irradiated Dry Yeast on Reproduction and General Health in Dairy Cows.** (J. G. Archibald and A. E. Conklin.) This practice, established some years ago for the production of metabolized vitamin D milk, is being investigated for its possible beneficial effect on the cows themselves. The work is being done in cooperation with Standard Brands, Inc., of New York City and the Massachusetts State Department of Health. Sixty cows in the herd of the Gardner State Hospital have been divided into two groups, one of which receives the regular herd ration while the other receives in addition irradiated yeast ( $\frac{1}{2}$  pound per ton of grain) for a period of two years. Careful records of milk production, reproductive function, and general herd health are being kept. The work has not yet been in progress long enough to yield any substantial amount of data or to warrant drawing any conclusions.

## DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

**Nitrification in Soils Containing Plant Residues of High Lignin Content.** (James E. Fuller.) This experiment is being carried on in cooperation with the Agronomy Department. In 1939 a number of plots were planted with crops having high lignin content. For comparison, some low-lignin crops were planted, and some plots were left fallow. In the fall the crops were plowed under. In 1940 tobacco was grown over the whole area. Soil samples were collected in the spring, in mid-season, and in fall. The ability of the soils of the samples to nitrify their own nitrogen and to nitrify dried blood was studied. The experiment is based on the theory that if it can be shown that certain crops plowed into the soil hamper the process of nitrification, it might follow that growth of plants (tobacco, for instance) would also be interfered with; and stunted, or even diseased crops, would result.

To date, no differences observed in the nitrifying capacities of the soils can be attributed to the crops plowed under. The experiment will be continued another year.

**Bacteriological Study of Spices and Spice Oils.** (James E. Fuller and Frederick J. Wishart.) Several standard brands of packaged spices were studied, including cinnamon, cloves, nutmeg, allspice, black pepper, red

pepper, paprika, and mustard. The bacteria found were common airborne varieties (*B. subtilis* group) that are of no particular sanitary significance. Intestinal bacteria (coliform group) were not present. Bacteria of intestinal types and of types capable of causing food poisoning (coliform bacteria, *Salmonella* strains, and staphylococci) inoculated into the several spices did not survive for more than a few weeks. Some oils of the spices were investigated and found to be sterile when they were purchased. Some were found to have the power to inhibit bacterial growth. More work will be done on this phase of the problem.

**Effects of Temperature on the Differential Reactions of Coliform Bacteria.** (James E. Fuller and Sonnia Levine.) The evaluation of the sanitary significance of certain members of the coliform group of bacteria in rural water supplies (springs and wells) offers some puzzling problems. The separation of definitely fecal strains from strains definitely of soil origin is relatively simple; but there are numbers of strains which give differential reactions between these two species, and the sanitary interpretation of the so-called intermediate strains presents the problems. Eijkman proposed incubating water-test cultures at 46° C., instead of at the usual 37° C., on the basis that the fecal strains would give positive tests for pollution (production of gas in lactose broth) at the higher temperature while other strains would not. In the present study the differential tests (Imvic reactions) of a number of intermediate strains were tried at several temperatures from 25° C. (room temperature) to 46° C. The evidence indicated that by this method certain of the intermediates could be placed in a group closely related to the fecal type (*Escherichia coli*). The indol test worked especially well in this respect.

**Studies of Fecal Streptococci.** (James E. Fuller and Robert S. Lubitz.) This study is a continuation of work previously reported (Fuller and Guiberson, Mass. Expt. Sta. Bul. 369, p. 20, 1940; France and Fuller, Amer. Jour. Pub. Health, 30 (9):1059-1062, 1940). In the bacteriological testing of swimming pool water, it is desirable to differentiate between fecal streptococci, and streptococci from the skin or from the nose and throat. The former would indicate pollution of the water from intestinal source, and the latter would indicate danger of skin or of respiratory infection to users of a pool.

In the study here reported an attempt was made to develop differential methods by the use of media of high pH value, or of high sodium-chloride content. Some information was obtained concerning the tolerance of fecal streptococci and of coliform bacteria to both high pH and high sodium-chloride concentrations in media. No successful differential procedure was developed.

**Bacteriological Studies of Chocolate Syrups and Cocoa Powders Used in Chocolate Milk.** (James E. Fuller and R. W. Swanson.) This study is being made in cooperation with W. S. Mueller of the Department of Dairy Industry. The work has been undertaken only recently, so only preliminary results can be given. The bacterial contents of the syrups and powders vary a great deal. There is little indication to date that the addition of either syrup or powder increases the bacterial counts of milk except for the addition of the bacteria present in the syrups or powders themselves. There is some indication that both chocolate and cocoa may have the capacity to hinder the growth of certain bacteria.



**Studies of Methods for Determining the Sanitary Quality of Drinking Utensils.** (Ralph L. France, W. E. Cassidy, and James E. Fuller.) Results obtained to date on this project are as follows: (1) The use of a wet swab on the glasses gives better results than a dry or a moist swab. (2) As a suspending medium and a diluting fluid phosphate water and saline were equally satisfactory. (3) A medium containing sodium chloride, yeast extract, neopeptone, and dextrose recovered more organisms than the standard plating agar. (4) All swabs should be iced immediately after collection if the elapsed time between sampling and laboratory testing is more than two hours.

**The Streptococci Test as an Index of the Sanitary Quality of Drinking Utensils.** (Ralph L. France.) A test for streptococci similar to that used in swimming pool sanitation might be used to determine the sanitary quality of drinking utensils. Results to date indicate that when a glass or cup has been improperly sanitized it is possible to obtain streptococci when the lip of the container is swabbed. In the case of a properly sanitized glass this is not possible. Further work of a practical nature will be carried on to add confirmation to these results.

**Neisseria Catarrhalis as an Index of Pollution in Swimming Pool Water.** (Ralph L. France.) The use of *N. catarrhalis*, an oral and nasal-passage organism, has been recommended as an index of pollution in swimming pool waters. A comparison of this method with the streptococci index and the coliform (Standard Method) index is being made. The results obtained to date suggest that the streptococci index is much more indicative of the actual sanitary conditions of a pool than is either of the other two methods. In fact, this writer has been unable, up to the date of this report, to isolate *N. catarrhalis* from swimming pool water by the method recommended.

**Laboratory Service.** (Ralph L. France.) Following is a list of the types and numbers of examinations made during the past year:

Milk (bacteria counts) .....	787
Ice cream (bacteria counts) .....	116
Water .....	150
Miscellaneous:	
Butter fats .....	2
Mastitis .....	2
Ropiness .....	1
Total .....	1,058

## SUMMARY OF SERVICE BACTERIOLOGY—1928 TO 1940

Year (Sept. 1- Aug. 31)	Paid Examinations				No-charge Examinations				Total Examinations for the Year
	Milk	Water	Misc.	Totals	Milk	Water	Misc.	Totals	
		*23							
1928-29 ..	432	144	35	634	653	33	8	694	1,328
1929-30 ..	466	211	47	724	326	5	4	335	1,059
1930-31 ..	745	117	66	928	288	32	0	320	1,248
1931-32 ..	899	88	223	1,210	270	35	1	306	1,516
1932-33 ..	782	81	314	1,177	305	39	14	358	1,535
1933-34 ..	801	60	57	918	196	18	6	214	1,132
1934-35 ..	873	82	99	1,054	251	16	0	267	1,321
1935-36 ..	1,133	79	256	1,468	304	6	24	334	1,802
1936-37 ..	1,098	86	499	1,683	389	33	20	442	2,125
1937-38 ..	739	106	504	1,349	382	22	62	466	1,815
+1938-39 ..	595	118	410	1,123	418	5	25	448	1,571
+1939-40 ..	438	130	178	746	465	20	15	500	1,246
Totals ..	9,001	1,325	2,688	13,014	4,247	264	173	4,684	17,698
Grand Totals	13,248	1,589	2,861						17,698
(Paid and No-charge)									

\*Chemical analyses.

†This sudden decline in the number of samples (mostly milk) can be traced directly to the installation of several municipal and private laboratories in this part of the state.

## DEPARTMENT OF BOTANY

## A. Vincent Osmun in Charge

**Diseases of Trees in Massachusetts.** (M. A. McKenzie and A. Vincent Osmun.)

*The Dutch Elm Disease Problem.* State-wide interest in the Dutch elm disease was intensified during 1940 as reports of affected trees in Columbia County, New York, and Litchfield County, Connecticut, established new stations for the causal fungus, *Ceratostomella ulmi* (Schwarz) Buisman, in areas immediately adjacent to the west and south of Massachusetts' boundaries, and the total number of trees found to be infected in the United States rose to 61,391. At the present time (December 2, 1940), no positive proof of the disease in the elms of Massachusetts has been established although hundreds of suspected trees have been checked in field and laboratory studies during the past year.

The work of the organized project of this Station in collecting and studying specimens from trees showing symptoms macroscopically indistinguishable from those of the Dutch elm disease has been supplemented by other public and private groups and individuals, including the Massachusetts Department of Agriculture, United States Department of Agriculture, The Massachusetts Forest and Park Association, town and city tree wardens, employees of other municipal and State departments, arboriculturists, and private citizens. Recently in cooperative investigations the Director of Plant Pest Control of the State Department of Agriculture has seen fit to invoke the provision of the Massachusetts statute for the destruction of trees infested with carrier insects of the causal fungus in two instances where elms were believed to be dangerously threatened by the disease. Connecticut, however, remains the only New England State in

which the presence of the Dutch elm disease has been definitely established, although a recent report in the eastern part of that State carries the disease to a point within ten miles of the Rhode Island line; and the presence of the disease in areas of infestation in New York near the Vermont line further threatens the elms of New England States other than Massachusetts.

During the past five years close surveillance of the elms in Massachusetts has revealed certain facts relative to the Dutch elm disease problem in Massachusetts. From time to time, considerable confusion has been encountered resulting from popular misunderstandings, of which the following is only one example. The necessity for accuracy in describing the disease as a result of infection by a fungus is frequently overlooked, and leaf beetles (which contribute to tree weakening) and bark beetles (which are believed to be the principal carriers of the causal fungus) are sometimes confused with the actual specific fungus disease. In practical application, however, the association of the various factors may not be far amiss if it is borne in mind that none of the factors which favor the development or spread of the disease can initiate the disease independent of the fungus which causes it. In a concise report<sup>1</sup> on this problem it was pointed out that the disease control program in the State has consistently worked toward the elimination of conditions which would be favorable to the establishment and spread of the disease within Massachusetts. Particular emphasis should be given to the reported danger from the carrier beetle (*Scolytus multistriatus* Marsh.) population in southwestern Massachusetts, which is continuous with the beetle population of the adjoining New York area where beetle-infested trees infected with the causal fungus have been found. The existence of a distinct area of infestation of this same carrier beetle in eastern Massachusetts has set the stage for the spread of the disease there if the causal fungus is permitted to be introduced and established widespread in the area, but obviously the elms of western and southwestern Massachusetts stand in more immediate danger because of the proximity of both the causal fungus and the carrier beetle.

The existence of a more or less natural barrier relatively free from elms in the southwestern corner of the State, together with the aggressive eradication programs for areas where the disease has been found may explain the delay in the spread of the disease to Massachusetts. Outside of Massachusetts, in programs for the eradication of the disease, 61,269 elms known to be infected with the disease fungus have been removed, in addition to 5,567,334 weakened or undesirable elms which have been removed because, as breeding places for carrier beetles or in some other way, they constituted conditions favorable for the spread of the disease. In Massachusetts, to the extent that municipalities are able to prevent the accumulation of elm material favorable for beetle breeding, a real obstacle to the rampant spread of the disease will be established.

If the fullest measure of benefit from the defensive campaign waged vigorously against the Dutch elm disease in the areas where the disease occurs outside of Massachusetts is to be realized, therefore, only a course of continued vigilance in an offensive and, if necessary, also a defensive campaign against the disease is open to Massachusetts.

<sup>1</sup> Osmus A. Vincent. The Dutch elm disease situation as it concerns Massachusetts. Published among "Transcriptions of Certain Papers presented at the Seventh Annual Five-Day Short Course for Tree Wardens and Foresters," M. S. C., March 30, 1940.



*Other Tree Problems.* Seventy-one fungus diseases of thirty-five species of trees or other woody plants, including twelve diseases of elm, were identified from more than 600 specimens and inquiries received during the year. *Cephalosporium* sp. was isolated from elms of 16 municipalities in which the wilt disease caused by this fungus was not previously known to occur, making a total number of 152 cities and towns in which the disease has been found in Massachusetts. The progress of the disease in individual mature trees was found to be far from uniform. In experiments also, trees subjected to controlled conditions were found to be affected in varying degrees following inoculation with the causal fungus. The latter observations suggest the significance of resistant individuals, while field observations suggest that additional factors involved in susceptibility include winter injury and drought.

Preliminary experiments on another wilt disease of elm, caused by *Verticillium* sp., showed more extensive injury to maples inoculated with the fungus, in pots under controlled conditions. The *Verticillium* wilt disease of elm is believed to be caused by the same fungus which causes the disease of maple known as Maple Wilt as well as other diseases resulting from infection of the water-conducting tissues in numerous additional plants. When elms and maples were inoculated with the fungus isolated from elm, the elms died back somewhat but never completely, while the maples were sometimes killed. The isolation of *Verticillium* sp. from trees of six municipalities in which the fungus had not been reported previously, increased to 77 the total number of cities and towns where the *Verticillium* wilt disease of elm is now known.

During the year, experiments and observations of a fungus, *Phomopsis Gardeniae*, as a cause of injury to gardenias were reported,<sup>2 3</sup> including in one instance a review of previous publications on this fungus.

The sycamore disease, caused by *Ceratostomella* sp., reported in New Jersey and elsewhere has not been found in Massachusetts as yet although so far as is known, no organized search has been made here.

A disease of maple known as Bleeding Canker has aroused widespread interest throughout the State. The fungus, *Phytophthora cactorum*, has been described as the cause of this disease by F. L. Howard and N. Caroselli.<sup>4</sup> A fungus believed to be the same species has been isolated in laboratory studies made from collections of elm, maple, and beech in Massachusetts, but no specific experimental work has been undertaken by this Station. The problem is recognized as a serious one since remedial treatment of affected, highly prized specimen trees may be desirable. Meager experimental work and the paucity of published data have resulted in a demand that work be undertaken by public agencies on this problem. The whole subject of tree therapeutics as well as the highly speculative and much misunderstood practice of tree injection is involved in this problem, which demands more concentrated attention than can be probably accorded to this research as a side line dominated by other major work. It is recognized, however, that the demand for investigation

<sup>2</sup> McKenzie, Malcolm A., Jones, Linus H. and Gilgut, Constantine J. *Phomopsis Gardeniae* in relation to gardenia culture. Plant Disease Reporter 24:3:58-62. February 15, 1940. (Contribution No. 363.)

<sup>3</sup> McKenzie, M. A., Jones, L. H. and Gilgut, C. J. Study practical gardenia canker control as disease increases (illus.). Flor. Rev. March 28, 1940. (Contribution No. 367.)

<sup>4</sup> Phytopathology 30:11. 1940.

on this problem is legitimate even if it cannot be met under present conditions.

At the request of the Massachusetts Tree Wardens' Association a report entitled, "Mortality in street tree planting"<sup>5</sup> was prepared; and a paper entitled, "The tree warden and the town forest" was presented at the Fifth Annual Conference on Current Governmental Problems, November 15-16, 1940.

Investigation of certain injury to trees and other plants revealed evidence that sulfur dioxide fumes from an electric refrigerator had caused sudden if temporary damage.<sup>6</sup>

Weather conditions of the early part of the 1940 growing season were particularly favorable for the spread of leaf-infecting fungi, and considerable injury to foliage also resulted in early summer from the burning of tender growth following foliage development. The period of dry weather previous to the freezing of the ground in the autumn of 1939 caused extensive injury to broadleaved and coniferous evergreens as well as less extensive injury to deciduous trees in certain localities.

Current miscellaneous activities of the project included the preparation of parts of the program of the Five-Day Short Course for Tree Wardens and the preparation of newspaper press releases.

**Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modification of Environment.** (W. L. Doran.) Sandy soil is proving to be a good rooting medium for cuttings of some species and a paper<sup>8</sup> was recently published on results obtained with it. Softwood, July, cuttings of *Styrax japonica*, *Cornus Kousa*, and Cornelian cherry treated with indolebutyric acid (12.5 or 25 mg. per liter for 18 or 20 hours) rooted 10 to 50 percent in sand, 70 to 100 percent in sandy soil. Untreated July cuttings of Pfitzer juniper rooted 100 percent in sandy soil, 83 percent and more slowly in sand; but hardwood, December, cuttings of that variety, after treatment (100 mg./l., 20 hr.), rooted better in sand. November cuttings of Gardenia rooted practically equally well in sand sterilized with hot water and in unsterilized sandy soil or sand-peat. Late fall cuttings of *Taxus media* and its variety *Hicksii*, treated with indolebutyric acid, rooted better in sand-peat than in sandy soil or sand, but untreated cuttings of *T. media* rooted 72 percent in sandy soil, 28 percent in sand. Similar cuttings of *Chamaecyparis obtusa* var. *filicoides*, untreated, rooted 57 percent in sandy soil, 28 percent in sand. November cuttings of *Picea glauca* var. *conica*, treated or not, rooted better in a mixture of sand, peat, and loam (3:1:1) than in either sandy soil or sand; best rooting, more than 90 percent, being of cuttings, treated with indolebutyric acid 50 mg./l., 18 hr.

Rooting of cuttings of white pine from mature trees has been considered difficult, but certain trees with unusually good characteristics from the viewpoint of the forester having recently been found here, their propaga-

<sup>5</sup>McKenzie, Malcolm A. Published in "Proceedings of the Annual Meeting of the Mass. Tree Wardens' Assn.," February 7 and 8, 1940.

<sup>6</sup>McKenzie, Malcolm A., and Jones, Linus H. Injury to trees from sulfur dioxide fumes of electric refrigerators. Science 91:2358:239-240. March 8, 1940. (Contribution No. 358.)

<sup>7</sup>Sulfur dioxide gas damages foliage. Science News Letter 37:2:184. March 23, 1940.

<sup>8</sup>Doran, William L. Soil as rooting medium for cuttings. Amer. Nurseryman 72:5:7-8. 1940. (Contribution No. 374.)

tion vegetatively was attempted. There was little or no success with cuttings, treated or not, which were taken in spring and summer; but cuttings taken in late winter from the lower, not the upper, branches of a tree about thirty years old rooted 70 percent in sand-peat in three months after treatment for 5 hours with indolebutyric acid 200 mg. per liter. Similar cuttings failed to root without treatment, and treatment with more dilute solutions of indolebutyric acid for 20 hours was too long. Some of the results of this work were published recently.\*

Solutions of root-inducing substances are more effective with cuttings of some species if used at higher than room temperatures. December cuttings of *Taxus media*, in sand, rooted 70 percent without treatment, 80 percent after treatment with indolebutyric acid (50 mg./l., 19 hr.) at an approximately constant temperature of 65° F., 100 percent (and more rapidly and with better roots) after similar treatment at an initial temperature of 86° F. for 3 hours followed by treatment with the same solution at 65° F. for 16 hours. November cuttings of *Picea pungens* var. *globosa* had their rooting improved by indolebutyric acid (25 mg./l.) applied at an initial temperature of 86° F., falling to 65° F.; but there was no improvement when it was applied at a constant temperature of 65° F.

Rooting of cuttings of several species, taken in late fall or early winter, was more improved by treatment for 16 to 24 hours with indolebutyric acid (50 or 100 mg./l.) in a sugar solution (2.5 percent) than by similar treatment with indolebutyric acid in water. Cuttings of Pfitzer juniper rooted 44 percent after treatment with indolebutyric acid in water, 100 percent after treatment with that acid in a sugar solution. Cuttings of a species of *Cytisus* rooted 40 percent in 16 weeks after treatment with indolebutyric acid in water, 60 percent in 7 weeks after treatment with that acid in a sugar solution. Cuttings of *Chamaecyparis obtusa* varieties *compacta* and *magnifica* responded similarly. Cuttings of *Taxus media* and *T. media* var. *Hicksii* rooted equally well, 100 percent, with either treatment, but the best roots were on cuttings treated with indolebutyric acid in a sugar solution. Cuttings of a variety of arbor-vitae and two varieties of Norway spruce did not respond to sugar, but cuttings of *Picea glauca* var. *conica* rooted 40 percent without treatment, 55 percent after treatment with indolebutyric acid in water, and 78 percent after treatment with indolebutyric acid in a sugar solution. Cuttings of Sawara cypress rooted in larger percentages after treatment with honey in solution, but there was no response on the part of cuttings of three other species.

Rooting of summer cuttings of Hinoki cypress and Pfitzer juniper was more improved by indolebutyric than by indoleacetic acid. Rooting of early July cuttings of a lilac was more improved by naphthaleneacetic acid (100 mg./l., 5 hr., gave best results) than by indolebutyric acid.

July cuttings of *Stewartia koreana* rooted less well if made of tips of shoots than if made to include all of the current year's growth. Best rooting, 100 percent, and much better than the untreated, was of cuttings treated with indolebutyric acid 50 mg./l., 20 hr.

Optimum concentrations of indolebutyric acid and lengths of time of treatment for cuttings of some other species were 25 mg./l., 20 hr., for Cornelian cherry (in July); 100 mg./l., 20 hr., for *Rhododendron minus* (in November); 50 mg./l., 20 hr., for *Picea glauca* var. *conica* (in November).

\*Doran, William L., Holdsworth, Robert P., and Rhodes, Arnold D. Propagation of white pine by cuttings. Jour. Forestry 38:517. 1940. (Contribution No. 372.)



Rooting of September cuttings of *Daphne Cneorum* was improved by treatment with 50 mg./l., 5 hr., or 12.5 or 25 mg./l., 20 hr. November cuttings of *Gardenia* rooted so well untreated that the only benefit of treatment (indolebutyric acid 25 mg./l., 24 hr., gave best results) was to hasten rooting a little. November cuttings of *Berberis candidula* rooted more than 80 percent without treatment, no better with treatment. December cuttings of Pfitzer juniper rooted 50 percent without treatment, 100 percent after treatment with indolebutyric acid 50 mg./l., 20 hr.

**Study of Diseases of Ornamental Herbaceous Plants Caused by Soil-Infesting Organisms, with Particular Attention to Control Measures.** (W. L. Doran.) Until better and cheaper soil disinfectants are found, it is important that more be learned about how best to use the old ones. Since damping-off is important and also convenient to work with, its control was here used as a measure of effectiveness, for what is learned in this way can be useful in efforts to control other and similar diseases caused by soil-infesting fungi.

In order to learn how the efficacy of certain soil disinfectants is affected by soil reaction, pH values of soil were adjusted with sulfur or with hydrated lime before soil treatment.

Formaldehyde was equally effective in soil with a pH value of 7.0 and in acid soils with pH values of 6.0 to 5.6.

Calcium cyanamide, 1000 pounds per acre, applied to soil two weeks before seeding, gave better control of damping-off and of a root-rot of sweet pea seedlings in soils with a pH value of 7.0 or higher than it did in a more acid soil with a pH value of 5.9. Sweet peas usually grow best, if they escape root-rot, in a soil which is not very acid and it was in such soil that calcium cyanamide was more effective.

Applications of acetic acid in the form of vinegar (about 200 cc. vinegar per square foot) which gave good control of damping-off in more acid soils at pH 5.7 to 6.0, gave poorer control in soils with pH values of 7.0 or higher. More vinegar is needed for good control in less acid soils and it was observed that a given quantity of vinegar can be used with greater safety in less acid soils than in those with a lower pH value. Growth of a few species was somewhat injured by vinegar applied to the more acid soils, but the growth of seedlings of all species used was unaffected or improved by vinegar applied to soil with a relatively high pH value. Growth of sweet peas was also improved by vinegar in the more acid soils for in such soils the control of root-rot was best. In soils with more lime, such as are usually used for sweet peas, vinegar would probably not, however, be the preferred soil disinfectant.

Aqua ammonia (containing 27 percent  $\text{NH}_3$ ) prevented damping-off equally well in soils with pH values of 6.9 and 7.2 and in acid soils with pH values of 5.7 and 5.3. Aqua ammonia, 8, 16, or 24 cc. per square foot, gave good results; but 24 cc. per square foot applied 7 or 10 days before seeding injured some species, and 16 cc. but not 12 cc., interfered with the germination of beets sowed immediately after soil treatment.

Soil treatments with ammonium sulfate and ammonium phosphate were without fungicidal effect in acid soil (pH 5.4 to 5.9), but ammonium sulfate had some fungicidal effect in soil recently limed. Heavy applications of ammonium sulfate which were harmless to germination in acid soil were decidedly injurious in the limed soil. This is probably due to the

effect of ammonia, the odor of which is sometimes strong when the salt is applied to limed soil.

With the object of determining the length of time that a soil-disinfesting effect persists, or how soon soils variously disinfested become badly reinfested, seeds were sowed at various intervals of time after treatment of soil in open flats in a greenhouse. Applied immediately before seeding, formaldehyde, calcium cyanamide, formic acid, salicylic acid, oxyquinoline sulfate, acetic acid, and vinegar were about equally effective although they were not equally safe; calcium cyanamide, especially, being harmful.

Formaldehyde gave good protection against damping-off for one week, fair protection for two weeks, very slight protection for three weeks, and none whatever when seeds were sowed four weeks after soil treatment. There was partial control by the other chemicals when seeds were sowed as late as four weeks after soil treatment. When they were sowed six weeks after soil treatment, the only chemical which still showed any protective effect was calcium cyanamide.

**Chemical Soil Surface Treatments in Hotbeds for Controlling Damping-off of Early Forcing Vegetables.** (W. L. Doran, E. F. Guba, and C. J. Gilgut.) In a continuation of the work of determining the least quantity of formaldehyde which is or may be effective and the search for more convenient ways to apply it, soil was watered, immediately after seeding, not with water alone but with dilute solutions of formaldehyde. They were so applied that each square foot of soil surface received 0.2 to 3.0 cc. formaldehyde in 1 quart of water.

There was poor or no control by 0.2 cc., but beet, cress, cucumber, and lettuce, the seeds of which germinate relatively rapidly, were well protected by as little as 0.6 cc. and nearly as well by 0.4 cc. per square foot. A little more may be needed when more slowly germinating seeds are involved, for seedlings of eggplant damped-off with 0.6 cc. But damping-off of all these species was as well controlled by 1.0 cc. per square foot as by heavier applications.

Such an application, 1 cc., leaves a considerable margin of safety, for 2 cc. per square foot did not injure the growth of seedlings of any species and injury to growth caused by 3 cc., slight to begin with, was soon outgrown. There is, however, more formaldehyde in recently treated soil during the germination of seeds than during the subsequent growth of seedlings, and it was several times observed that germination may be injured by applications which do not affect growth. Germination of the other species was not injured by 3 cc., but germination of cress was somewhat retarded by 2 cc., not by 1.6 cc., per square foot. Crucifers are especially susceptible to injury by formaldehyde and, for them, about 1.5 cc. formaldehyde per square foot, applied as above, is probably the limit of safety.

Dusting of seeds of crucifers with zinc oxide or, in some cases, with Semesan resulted in better stands of seedlings than did the application of formaldehyde to soil after seeding. Both zinc oxide and Semesan dust, as seed treatments, gave better results with crucifers than did red copper oxide.

Formaldehyde 1.9 cc. (in 0.8 quart water) per square foot gave good control of damping-off of spinach, lettuce, pepper, cucumber, beet, and tomato, but about 2.5 cc. gave better control with celery and Swiss chard. That quantity of water per square foot is not too much if soil is not too

wet to begin with; but it caused some packing and puddling of soil which was already too nearly saturated before treatment.

**Carnation Blight Caused by *Alternaria dianthi* S. & H.** (E. F. Guba, Waltham.) Seedling carnations obtained from last year's breeding work are now benched and growing in the greenhouse. As yet there is no indication that any of the seedlings are more resistant than the parents to either *Alternaria* blight or branch rot caused by *Fusarium dianthi* Prill. & Delacr.

**Control of Greenhouse Vegetable Diseases.** (E. F. Guba and C. J. Gilgut, Waltham.) Observations on resistance of the Bay State tomato to the tomato leaf-mold disease caused by *Cladosporium fulvum* Cke. were made on crops grown under commercial conditions, in a number of greenhouses. Under such conditions, this tomato showed 25 percent of the plants to be susceptible to leaf mold while the remainder are highly resistant. The Bay State tomato is highly pleasing to growers who in the past have frequently experienced complete loss of their fall-winter crop due to this disease. The yield has been found satisfactory. The one criticism of growers is that the fruit does not ripen fast enough.

The Bay State tomato is not a substitute for good greenhouse management. In two establishments it was found that nearly all of the plants had some mold on them. It was learned that the impression was prevalent among growers that the plants could be more or less neglected and still remain free of mold. If managed as carefully as the highly susceptible varieties of greenhouse tomato, the Bay State variety, grown as a fall-winter crop, is highly resistant to the leaf-mold disease and gives far more satisfactory results.

**Factors Affecting Yield of Onions and Their Shrinkage in Storage.** (C. J. Gilgut and W. G. Colby. Cooperative with Agronomy.) Twenty-six lots of onion sets were grown on typical Connecticut Valley onion soil and compared for yield and shrinkage in storage. All lots were obtained in the Valley, except six small lots for experimental trial which were shipped direct from a mid-west producing area.

There was less difference in performance of locally grown Japanese seed sets and those shipped in than was the case last year. Locally grown Japanese sets produced slightly higher yields than those shipped in, but there was no significant difference in the yield of globe type seed sets from different sources.

After 90 days in storage, shrinkage resulting from disease averaged 17.8 percent for locally grown Japanese sets and 28.6 percent for three lots of shipped in Japanese sets. The average shrinkage of globe type sets was 24.5 percent for those grown locally and 25.7 percent for those shipped in. However, the lots of globe type sets obtained for experimental trial averaged 49.3 percent shrinkage. The large shrinkage loss in this case can probably be accounted for by the fact that the sets were shipped in airtight paper bags—the seed sets heated in transit and mold had developed on the basal plates. The development of mold did not affect the growth of these sets in the field. The average yield was highest of any globe sets tested.

In accordance with last year's results, it was found that in the early part of the storage period bacterial soft rot predominated, while later *Fusarium* bottom rot was more prevalent.

In harvesting experiments onions pulled, clipped, and stored the same



day showed a shrinkage of 14.1 percent when stored in 50 pound crates, and 22.7 percent when stored in 50 pound bags.

In rotation experiments the shrinkage after 90 days in storage of onions grown after one year hay sod was 13.5 percent; of onions after a ryegrass cover crop, 22.4 percent; and of onions directly after onions, 17.3 percent. These are the first year's results on land which has produced onions continuously for more than 40 years.

**Miscellaneous Tests and Experiments.** (E. F. Guba and C. J. Gilgut, Waltham.)

1. *Apple Scab Control.* Wettable sulfurs used on an equivalent sulfur basis were compared for scab control, fruit russet, and leaf injury. All applications, except the pink and third cover sprays, contained 3 pounds of lead arsenate to 100 gallons of spray with or without 6 pounds of lime. Seven applications were made, beginning with the pre-pink on May 9 and ending on July 8. Delicious, McIntosh, and Greening varieties were used during the experiment. Fruit russet was found only on Delicious.

Kolofog, 6 pounds to 100 gallons, and micronized sulfur, 1.8 pounds to 100 gallons, used with 3 pounds of lead arsenate and with or without 6 pounds of lime, gave good control of scab on all three varieties of apples sprayed. Fruit russet produced by the Kolofog-lead arsenate spray was reduced from 17.9 percent to 9.6 percent when lime was added. The russet caused by the micronized sulfur-lead arsenate mixture was reduced by lime from 10.9 percent to 8.7 percent.

Magnetic sulfur, 1.8 pounds to 100 gallons, lead arsenate 3 pounds, and 1 pound of a commercial preparation of zinc sulfate gave less control of scab on McIntosh and Greenings, and slightly better control than most sprays on Delicious. Fruit russet was increased by this mixture.

The best scab control on McIntosh was obtained by Kolofog-lead arsenate-lime and by liquid lime-sulfur 2 gallons to 100 gallons in the precover sprays, and in the cover sprays magnetic sulfur 8 pounds, lead arsenate 3 pounds, manganese sulfate 2 ounces, soybean flour  $\frac{1}{2}$  ounce and lime 6 pounds. However, the latter treatment caused 23 percent fruit russet, a considerable increase over that produced by the wettable sulfur sprays containing lead arsenate with or without lime.

Leaf injury, as evidenced by yellow leaves, leaf drop, and the amount of foliage remaining on the trees at the time the apples were picked, was consistently more severe on those trees sprayed with the Kolofog-lead arsenate mixture. The most severe injury was on Delicious, which lost about 25 percent of the leaves, while the McIntosh and Greening trees lost about 8 percent each.

2. *Copper Dusts for Vegetables.* Eighteen brands of commercial prepared copper dusts were tested on cucumbers and muskmelons in the field. The copper content of the dusts varied from 3.15 to 8.8 percent.

The cucumbers were destroyed by mosaic very early in the season, in spite of good control of aphids, and no yield records or observations on fungus disease control could be obtained.

The melons grew well throughout the season and downy mildew did not appear until late. There was no noticeable difference in appearance of the foliage of the plots which were dusted and those which received no treatment. There was, however, a considerable difference in yield. The best yields were obtained with Copper Hydro Dust C (copper 8.8 percent, calcium arsenate 20 percent); Rohm and Haas Dust No. 4 (copper 5.16

percent, rotenone 0.75 percent, flour 5 percent; balance clay or talc); Copper Hydro Dust E (copper 8.8 percent, rotenone 0.75 percent); Lab 789 (copper zeolite to make 5 percent copper, calcium arsenate 10 percent, flour 10 percent, balance talc).

**Dormancy of Gardenia Plants.** (L. H. Jones.) A group of the Belmont strain of gardenias suddenly became dormant in the early autumn. The dormancy was characterized by a dark, dull green color and a cessation of growth. Passing the hand quickly through the foliage gave a sound as if the leaves were of paper. Attempts to break dormancy by extremes of temperature, high and low (55° F. to 90° F.), of both air and soil failed.

Of these dormant plants, more than half were infected with *Phomopsis gardeniae*, causing gardenia canker. The plants were to be used in experiments concerned with an investigation of soil temperature and chlorosis. It is known that the larger-flowered varieties, to which belongs the Belmont strain, react more quickly to any treatment affecting growth. These larger-flowered varieties are also more susceptible to the canker disease. In one greenhouse, in a bed of 231 plants, 71 percent were affected with trunk cankers.

For research work, other than problems concerned with disease, it is advisable to use *Gardenia veitchii*.

During the early winter of 1939, bud-drop was not prevalent locally, probably because of an above-normal amount of sunshine in the late autumn, which favored continued growth.

**Changes in Root Temperature Cause Plants to Wilt.** (L. H. Jones and G. E. O'Brien. Cooperative with Chemistry.) The sudden lowering of root temperature or the rapid increase of air temperature causes plants to wilt. The wilting may be followed by the death of tissue in areas along the margin and between veins. These drought spots indicate that water has been lost from these areas more rapidly than it could be absorbed by the roots. Root media of soil, sand, or water were all equally inefficient in protecting the plant from this type of injury.

Soybean plants, even in solution culture, wilted and suffered drought injury when the solution was cooled from 70° F. to 50° F. by placing the culture in a water bath at 50° F. However, it was learned that the plants can be acclimated to this low temperature if the temperature is slowly reduced during the dark hours of the night.

**Stimulating Photosynthetic Activity.** (L. H. Jones and B. Eames.) Negative results were obtained from tests of a proprietary eosin-like material designed to increase growth by stimulating photosynthetic activity. The tests were made with begonia and geranium plants during the winter, when sunlight is at a minimum and when results would be most marked and most advantageous. Check plants and test plants received equal amounts of water and light. The chemical in solution form was applied weekly to the test plants which, at the end of the period, showed no increase in root development, size of plant, or number of blossoms, as compared with the check plants.

**The Effect of Root Media on Root Structure.** (L. H. Jones and B. Eames.) There is evidence accruing to indicate that artificial soil and substitutes for soils alter the root systems of plants. Roots developed in one extreme of media, as sand, will sustain the plant when put into the

other extreme, i.e., water; but new growth must wait until a new set of roots is produced. Literature intimates that there is a difference in roots in different media, but there is no information in regard to just what the difference is. A study with the microscope may reveal certain differences of structure.

**The Nature of an Oxidant in a Nutrient Solution.** (L. H. Jones, C. A. Peters, and W. B. Shepardson. Cooperative with Chemistry.) When the solution of a soybean plant culture is covered by a mineral oil film, an oxidant is produced in the solution that can be quantitatively determined by the Micro-Winkler method for the determination of dissolved oxygen. The oxidant is not  $O_2$ ; it is cumulative in the solution but not cumulative in the plant; it is produced by a living plant but not by a dead plant; the small amount of nitrites sometimes associated with it does not interfere with the quantitative determination.

If, in determining the oxidant by the Micro-Winkler method for oxygen, the sample is allowed to stand for a half hour after it is ready for titration, no returning end point is obtained. However, if the sample is titrated immediately, the end point is indefinite and continuing. This end point, if continued, will eventually come to the same figure as obtained after the half hour wait. The production of this oxidant by a plant is not understood and its composition is unknown. Some facts about its action under various conditions may aid in determining more exactly the nature and substance of this particular oxidant.

## DEPARTMENT OF CHEMISTRY

W. S. Ritchie in Charge

**Cooperative Analytical Service.** (The Department.) Thirty-four samples of blueberry bushes raised in the greenhouse in sand cultures by the Pomology Department were sent to the laboratory to determine their response to various nutrient solutions. The yield of air-dry leaves was determined in all cases, and the percentages of nitrogen, crude ash, and iron in dry matter in 13 composites. The yield in several instances was so small that further investigation was not possible. Freezing-point determinations were made on ten of the nutrient solutions as a measure of concentrations.

The manganese, calcium, and phosphorus were determined in a poultry ration as well as in the calcite added to it. The manganese in the egg (shell and yolk) was also determined as part of the study to evaluate the role of this element in the life processes of the chicken. Details of this work will appear under the report of the Poultry Department.

**Spray materials.** Several samples of spray material were submitted for analysis, including two lots of nicotine, fish-oil soap cartridges used for the control of aphids, which tested 6.79 and 5.83 percent of nicotine respectively. The soap in both instances was fairly soluble and left but slight residue.

A sample of so-called Fruitone, which is applied as a spray to retard apple drop, was received from the Pomology Department. This was a fairly soft white powder used at the rate of 1 pound to 200 gallons, and consisted of about 54.50 percent of talc (spreader) and 39.50 percent of organic acids (as citric by titration), together with some hygroscopic moisture and a small percentage of declared naphthalene compounds.



Other service rendered included the analysis of cocoa for iron, the qualitative examination of material found to be limestone, and the determination of the strength of a commercial sample of formaldehyde.

Carotene and chlorophyll were determined in two standard samples and one local sample (spinach and alfalfa) by several methods as collaborative work on A. O. A. C. methods for these constituents in feed-stuffs.

**Testing Analytical Methods. (The Department.)** In furtherance of the collaborative work on zinc in foodstuffs under the auspices of the A. O. A. C., samples of white dent corn (Johnson County Ensilage) and of spinach (Burpee's Victoria), together with granulated zinc for standardizing, were sent to analysts who had expressed a willingness to take part. Results by the Massachusetts method were promising, on the whole, but revealed some possible errors in technique that could be easily remedied. The suggestions for the coming year call for additional investigation to insure greater accuracy and easier operation as follows:

1. Complete solution of the zinc in hydrochloric acid.
2. Prevention or at least reduction of contamination by the glassware.
3. Use of dithizone in carbon tetrachloride when a suitable colorimeter and filters are available for a "mixed color" method.
4. Adoption of a specific color filter for the determination.

**The Iron, Copper, Zinc, and Iodine Content of Fruits and Vegetables Used as Human Food.** (E. B. Holland, C. P. Jones, and W. S. Ritchie.) The analyses of some 324 foodstuffs conducted during the past few years have now been completed. The analyses include proximate constituents and trace metals in fruits, vegetables, cereals, nuts, processed human and cattle feeds, and roughage.

**Lignin and Its Relation to the Absorption of Minerals by Plants.** (Emmett Bennett.) A thorough description of the objectives of this project has appeared in previous annual reports.

Last year it was noted that when corncob lignin was dispersed in sodium hydroxide and titrated electrometrically with a strong acid, data were obtained which, when plotted, produced a titration curve having two inflection points—one at about pH 4.5 and the other at about pH 8.0. A study was made of the conditions necessary to reproduce this curve. Such behavior is indicative of the activity of definite chemical groups. In some instances data may be obtained from titration curves which may be of assistance in determining the nature of the active groups. From the data obtained in this study "apparent dissociation" constants were calculated. These values were found to be comparable to the dissociation constants of substances containing phenolic hydroxyl and weak carboxyl groups. This relative agreement, however, is not conclusive evidence of the presence of phenolic hydroxyl and carboxyl groups in the material tested.

A study of the base exchange capacity of purified lignin indicated a low value. However, solution in alkali followed by precipitation and subsequent electro dialysis increased the exchange value many times. The enhanced value of the specially prepared lignin was reduced to the level of that of the original by drying at about 80°C. The enhancement in capacity is believed to be due chiefly to increased state of hydration made possible by previous treatment.

*Precursors of Lignin.* Data obtained from an investigation on Kentucky blue grass (*Poa pratensis*) and red clover (*Trifolium pratense*) showed no apparent relationship between pectic substances, hemicelluloses, and lignin. The lignin in red clover was associated with approximately an equal amount of pectic substances. On the other hand, Kentucky blue grass, containing an amount of lignin nearly equal to that of red clover, showed little more than a trace of pectic substances. The older plants contained about the same percentage of the pectic substances as the younger ones. The percentage of total hemicelluloses in Kentucky blue grass was about twice that in red clover.

It seems, therefore, that variations in the proportions of the three substances in the two species are probably due to differences in cell structure rather than to transformations; and that pectic substances are not found chiefly in the younger tissues.

A description of this work can be found in *Science* 91:95-96, 1940; and in *Plant Physiol.* 15: 327-334, 1940.

**Effect of Storage and Processing on Carbohydrates of Some Varieties of Edible Onions.** (Emmett Bennett.) A description of this project was given in the annual reports for 1938 and 1939. The results from investigations on the storage of the Ebenezer onion indicated the following:

1. Soluble carbohydrates constituted approximately 60 percent of the dry matter of the onion.
2. Reducing sugars accumulated to the greatest extent in the coldest storage.
3. Loss of total soluble carbohydrates was negligible in the onions which remained sound in storage.
4. The chief losses in storage were due to decay and sprouting.
5. Low temperatures retarded the losses.

Boiling onions in the usual way for consumption decreased the content of non-reducing sugars about 13 percent.

Details of this work have been summarized and submitted for publication in the *Proceedings of the American Society for Horticultural Science*.

**Chemical Changes in the Cooking of Vegetables.** (M. E. Freeman and W. S. Ritchie.) The cells of baked potatoes are separated to a greater extent in mealy tissue than in waxy tissue. Previously it was shown that this does not seem to be caused by the lack or weakness of the pectinous cementing material between the cells. New technique has given additional evidence of the cell separation in mealy tissue. When slices of freshly baked potatoes are dried, the mealy tissue becomes very porous. In the waxy tissue, however, the cells adhere so firmly that the material shrinks to a dense vitreous mass. The difference between mealy and waxy tissue is so apparent that the texture can be easily scored. There are several important advantages in this method of scoring texture: (1) the dried slices can be kept as a permanent record of any test; (2) the permanent standards can be selected and used for direct comparison with any test; (3) standards can be easily exchanged by any laboratories that wish to compare their results on the same scoring basis.

From the foregoing observations, it would seem that a quantitative measure of the pore surface or pore volume of the dried slices might serve as a quantitative measure of texture. Preliminary experiments on this point have met with some success.

Texture is also highly correlated with dry matter (starch) or moisture content. This relationship has been confirmed by additional analyses for these constituents. It has been found that the specific gravity of the potato closely parallels the average moisture content, but that different parts of a tuber may vary considerably in moisture, specific gravity, and texture. When the moisture content of raw potatoes was substantially and uniformly increased, the specific gravities and, in many cases, the texture scores were lower than in the controls. The results, however, did not conclusively demonstrate a causal relationship between moisture content and texture. Moisture content of potatoes was successfully lowered only at higher temperatures, and these moisture losses were not uniform. Tubers lost 40 percent of their total moisture while the interior flesh lost only 1 to 3 percent.

The moisture-texture relationship has been investigated by studying the water-binding capacity of potato tissue and starch. Since none of the usual methods for the determination of bound water have been entirely satisfactory for these materials, modifications and their application to various starches and potato samples have been studied.

**Progressive Decomposition of Fish Muscle.** (W. S. Ritchie and P. N. Simon.) Changes in the physico-chemical nature of the proteins should mark the first stages in the progressive decomposition of fish muscle. Attempts to detect such changes have been made by extracting or peptizing fresh haddock muscle with water and with sodium chloride solutions of different concentrations and at different temperatures.

Typical peptization curves were indicated by the total nitrogen extracted. The maximum amount was obtained with 10 percent sodium chloride at 0°C for a 24-hour period. The slope of the curve varied with the time and temperature of extraction. Significant differences in the coagulable and non-coagulable protein fractions were obtained at 0° and 25°C with certain salt concentrations; but there was no significant change in the values obtained at 0°C with storage up to eleven days. There was, however, an apparent but unexplained increase in the total nitrogen of haddock muscle with storage time.

Twelve pounds of haddock muscle were stored for twenty days at 10° to 12°C and decomposition products were extracted with solvents.

An ethyl alcohol extract yielded a dark-brown gummy residue which was soluble in water but insoluble in ether and acetone. The components of this residue could not be separated or crystallized by dehydration. Separation by electrodialysis resulted in decomposition of the components at the cathode. Treatment with HCl effected only a partial crystallization.

N-butyl alcohol yielded mixtures of decomposition products that were easily decomposed by such mild treatment as vacuum distillation. Picrate derivatives were prepared, however, with some measure of success. Of the sixteen picrate preparations some were very unstable on recrystallization; all decomposed when heated in melting-point tubes. Identification of the picrate derivatives is being attempted by ultimate analysis.

**The Influence of Base Exchange Capacity and of Exchangeable Ions in Massachusetts Soils on the Availability of Potassium.** (Dale H. Sieling.) Samples of representative soils of Massachusetts have been collected and are being prepared for laboratory investigation. The various horizons of sixteen soils have been included in this collection, and from these samples



information should be gained which will lead to the selection of the soils most suitable for this investigation when the phase of work related to plant growth is started. Preliminary investigations of the various physical and chemical characteristics of these soils are being made at the present time.

**The Relationship of Base Exchange Capacity, Exchangeable Hydrogen, and Soil Reaction to the Lime Requirement of Massachusetts Soils.** (Dale H. Sieling.) Sixteen soils representing the most important soil types in Massachusetts have been collected for the laboratory investigation in this research. Arrangements have been made with several of the farmers involved to lay out liming tests on a small area of their farms after the laboratory information is adequate to give an indication of the amounts required for the various soil types.

The volume-weight determinations of these 16 soils as they occur in the field have been made and show that under field conditions the weight per acre-inch varies from 101.5 tons to 151.0 tons. These variations in volume weights should have a marked influence on the lime requirements of the different soils on the basis of laboratory tests made on weighed quantities of soils.

**The Fixation of Arsenic in Soils and the Influence of Arsenic Compounds on the Liberation of Fixed Phosphorus in Soils.** (Dale H. Sieling.) Soil samples have been collected from plots 4 and 8 of Block K in the Pomology Fertilizer Test Plots. These plots have received the residue from several years of spraying with lead arsenate. On plot 8, where there has been no application of phosphorus, a definite deficiency of phosphorus is noted. Samples were collected at various depths in the soil to find whether the arsenic had penetrated beyond the top few inches of the soil.

## CONTROL SERVICE

Philip H. Smith in Charge\*

With the retirement of Mr. H. D. Haskins in December 1939, Fertilizer Control was merged with the other Control Services. At the present time, the Fertilizer, Feed, and Seed Control Laws and the Dairy Law are all administered as one service. In addition, a large amount of work is done not only for other departments of the institution, but also for other State institutions and for citizens as well.

**Fertilizer Inspection.** Records for the year show that 121 firms have registered 492 brands of mixed fertilizers and fertilizing materials and 52 brands of agricultural lime and gypsum. The gross receipts from the registration of the fertilizer and lime products and from fertilizer tonnage fees were \$14,491.28.

For inspection purposes 1,815 samples, representing 534 brands and 13,254 tons of materials, were drawn from stock found in the possession of 425 agents or owners located in 157 towns and cities of the State.

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\* The Control Service Staff consists of: Philip H. Smith in charge; F. A. McLaughlin, Seed Analyst and Microscopist; J. W. Kuzmeski, H. R. DeRose, A. F. Spelman, L. V. Crowley, F. J. Farren, Chemists; Jessie L. Anderson, Seed Analyst; James T. Howard, Sampling Agent and Inspector; G. E. Taylor, Laboratory Assistant.

The following summary shows the character of these substances, as well as statistics with reference to their inspection:—

	Brands Registered	Brands Collected	Samples Drawn
Mixed fertilizers .....	317	328	1,029
Ground bone, tankage and fish .....	39	35	133
Nitrogen products, mineral and organic .....	47	40	214
Phosphoric acid products .....	26	25	121
Potash products .....	21	21	84
Dried pulverized natural manures .....	26	26	95
Nitrate of potash .....	7	6	18
Peat products .....	2	2	3
Wood and cotton hull ashes .....	5	5	9
Miscellaneous .....	2	2	8
Lime products .....	52	44	103
Totals .....	544	534	1,817

**Feed Inspection.** During the fiscal year 1,628 samples of feeding stuffs were officially collected and examined in the control laboratories. The gross receipts from the registration of feeding stuffs in 1940 were \$25,300, derived from 1,265 brands at \$20 each.

**Dairy Law.** During the year ending December 1, 1940, 7,838 pieces of Babcock glassware were tested; 93 certificates of proficiency were awarded; and 235 creameries, milk depots, and milk inspectors' laboratories were visited in order to check methods and to pass upon equipment in use. As a result of this inspection, three machines were condemned. These will be either replaced or put into condition to operate satisfactorily.

**Miscellaneous Analytical Work.** (Fertilizer and Feed Laboratory). In addition to the work required by the several regulatory activities under its administration, Control Service is interested in collaborative work with other departments of the Experiment Station and College; the examination of samples of feeds, fertilizers, and other agricultural products submitted by citizens of the State; the testing of feeds and fertilizer bought by State institutions; and investigational work on new methods of chemical analysis for the Association of Official Agricultural Chemists.

In order to indicate the wide scope of the work, the following statistical data are appended:—

Apple spray residue .....	7
Feeds, from farmers and dealers .....	63
Feeds, from State institutions .....	959
Feeds and forage crops, Experiment Station .....	348
Fertilizer mixtures .....	40
Ice Cream .....	113
Insecticides and fungicides .....	7
Limestone (AAA distribution) .....	26
Milk .....	351
Peat .....	11
Poultry feces (In connection with experiments) .....	76
Poultry grits .....	3
Poultry manures (Fertilizer) .....	3

Referee and check samples, fertilizer and feed.....	17
Tannin in cocoa .....	24
Specimens for mineral poison .....	5
Sewage deposits .....	4
Superphosphate (AAA administration) .....	19
Water .....	3
Miscellaneous .....	10

**Seed Control.** From December 1, 1939, to December 1, 1940, the Seed Laboratory received and worked 2900 samples of seed, of which 1055 were collected by the State Commissioner of Agriculture and 1845 were sent in by seedsmen, farmers, and various State institutions. In addition, 194 samples of flower seeds, for field tests only, were also received from the State Commissioner of Agriculture.

Classification of these samples, with the total number of laboratory tests involved, is shown in the following summary. It will be noted that 4100 tests were required for the 2900 samples; 870 for purity, and 3230 for germination.

Number of Samples		Number of Tests	
		Purity	Germination
721	Field Crops for Purity and Germination .....	721	721
5	Field Crops for Purity Only .....	5	.....
181	Field Crops for Germination Only .....	.....	181
103	Lawn and Other Types of Mixtures for Purity, Germinations involving 440 ingredients .....	103	440
41	Lawn Mixtures for Purity Only .....	41	.....
13	Lawn Mixtures for Germination Only, Germina- tions involving 52 ingredients .....	.....	52
1542	Vegetables for Germination Only .....	.....	1542
43	Herbs for Germination Only .....	.....	43
98	Flower Seeds for Germination Only .....	.....	98
147	Tobacco Seeds for Germination Only .....	.....	147
6	Tree Seeds for Germination Only .....	.....	6
2900	Totals .....	870	3230

Field tests to determine trueness to type were conducted in cooperation with the Departments of Olericulture, Floriculture, and Agronomy, which tested 253 samples of vegetable seeds, 194 samples of flower seeds, and 123 samples of corn, respectively.

The Seed Laboratory cleaned 2 lots of onion seed and 100 lots of tobacco seed for Connecticut Valley farmers. The gross weight of the tobacco seed was 156.7 pounds and the net weight for the cleaned seed was 121.5 pounds.

Corn, oats, barley, and wheat, (187 samples), purchased by various State institutions, were examined for conformity to grade purchased; and 84 samples of ground cattle and poultry feed, collected by inspectors or sent in by dealers and farmers, were examined microscopically.



THE CRANBERRY STATION<sup>1</sup>

East Wareham, Massachusetts

H. J. Franklin in Charge

Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.)

*Hill Fireworm* (*Traslaca finitella* (Walker)). In the last annual report of the cranberry station,<sup>1</sup> some pupae of this species were mentioned as remaining on November 27, 1939. These pupae lived through the winter and spring and their moths emerged June 9 to 15. These moths were all somewhat larger than those that had come out in late August and early September, their wing expanse being about fifteen-sixteenths of an inch and their length to their wing tips about seven-sixteenths of an inch.

A severe infestation by this insect occurred this season on a bog at Onset, Mass., over an acre replanted in May 1940 being badly damaged.

*Cranberry Weevil* (*Anthonomus musculus*). The following treatments were tried on this pest:

1. Six pounds of tartar emetic and 24 pounds of brown sugar in 100 gallons of water, 400 gallons to an acre, applied on June 8, 1940, reduced the count in a week from 52 to 20 weevils to 50 sweeps of the net, and only a very light infestation of the new brood was found on the treated area on August 6.

2. Basic copper arsenate, a new product of the Sherwin-Williams Co., applied on August 6 at the rate of 6 pounds in 100 gallons of water, 400 gallons to an acre, killed 94 percent of the weevils of an infestation of 134 to 50 sweeps of the net.

3. A broadcast of 200 pounds to an acre of Go West weevil bait on June 6 reduced an infestation of 210 weevils to 50 sweeps of the net 68 percent in 8 days.

4. Barium fluosilicate, applied on August 6 at the rate of 6 pounds in 100 gallons of water, 400 gallons to an acre, killed 90 percent of the weevils of an infestation of 86 to 50 sweeps of the net.

5. Cryolite used as a spray, 6 pounds in 100 gallons of water, 400 gallons to an acre, or as a dust, 30 pounds to an acre, was very effective in many cases but only moderately so in others. This variation in results may have been due to different timing of the treatments relative to the main feeding periods of the weevils.

In the experience with this insect so far, the Bordeaux mixture-calcium arsenate-soap spray, basic copper arsenate spray, cryolite spray and dust, and very high grade (Kenia) pyrethrum dust have been the more effective insecticide treatments.

*Cranberry Aphid* (*Myzus scammelli* Mason). This species, lately described as new,<sup>2</sup> has been under the writer's observation for thirty years. It is found only on bogs which are not reflowed during the growing season. It is sometimes quite abundant and would be an important pest were it not well checked by its natural enemies, the larvae and adults of the following lady beetles, named in the order of their importance in this, being very effective<sup>3</sup>; *Coccinella transversoguttata* F., *Coccinella 9-notata* Herbst., *Hippodamia parenthesis* Say, *Coccinella 11-punctata* L.

<sup>1</sup>Mass. Agr. Expt. Sta. Bul. 369:34. 1940.

<sup>2</sup>Mason, Preston W. A revision of the North American aphids of the genus *Myzus*. U. S. Dept. Agr. Misc. Pub. 371, pp. 2, 5, 18. 1940.

*Cranberry Root Grub* (*Amphicoma vulpina*). One of the cranberry growers made an interesting attempt to kill the grubs of this pest by flooding an infested bog on May 10 with a solution of sodium cyanide, 6 ounces to 100 gallons of water. The cyanide was added by a measured feed to the water of the flood at the flooding gate in the form of a strong stock solution. This poisoned flood remained on the bog 27 hours, and analyses made from time to time showed that the poison was disseminated over the bog in quite even strength and that its strength was well maintained. This treatment did not harm the cranberry vines noticeably, but it killed hardly 70 percent of the grubs, being very definitely less effective than the usual cyanide application with pumping rigs and hose. It was also, of course, much more costly.

On May 15, paradichlorobenzene was used to kill these grubs. It was applied with a fertilizer distributor, at the rate of 600, 800, and 1200 pounds to the acre on different plots, and then covered with nearly an inch of sand. It was necessary to use the chemical in crystals of the particle size of very coarse salt, for larger crystals did not feed through a distributor well and fine ones did not sift down through the cranberry vines so as to cover the bog floor beneath them evenly. The chemical slowly volatilizes into a non-inflammable gas five times as heavy as air and permeates the surface soil thoroughly. The gas acts slowly and takes several weeks to kill insects. In these experiments, the kill was finally practically complete with 1200 pounds to the acre, and 800 pounds killed half the grubs. Further experience with this treatment is needed, but it may be useful on bogs that drain into public water supplies or into waters with fish, where cyanide cannot be used safely. It is much costlier than the cyanide treatment, the price of paradichlorobenzene being about 12 cents a pound.

Paradichlorobenzene was also applied to a large plot on August 10, at the rate of 1200 pounds to an acre, and the resulting kill in this case, as determined on October 7, was very unsatisfactory.

*Gypsy Moth* (*Porthetria dispar*). Cryolite used as a spray, 6 pounds in 100 gallons of water, 400 gallons to an acre, and as a dust, 30 pounds to an acre, was effective in killing the caterpillars of the gypsy moth and of the false armyworm in somewhat later stages of growth than is lead arsenate, but it failed to check maturing gypsy moth caterpillars. Derris powder (4 percent rotenone), 15 pounds in 100 gallons of water with 2 pounds of soap, 400 gallons to an acre, killed maturing gypsy moth caterpillars fully as well as pyrethrum dusts and at considerably less cost. Basic copper arsenate, 6 pounds in 100 gallons of water, 250 gallons to an acre, was more effective in killing maturing gypsy moth caterpillars than any other strictly stomach poison ever tried in our cranberry investigations. Though it was somewhat less effective than pyrethrum and derris, it probably will often be useful against the largely grown caterpillars where the crop prospect is poor and the main object is to save the vines.

*Grape Anomala* (*Anomala errans*). Grubs of this species were found early in May throughout a bog of 17 acres in the Wenham section of Carver.

*Black-headed Fireworm* (*Rhopobota*). Basic copper arsenate, 6 pounds in 100 gallons of water, 250 gallons to an acre, failed entirely as a treatment

<sup>3</sup> Named by Dr. Richard Dow, Curator of Insects of the Boston Society of Natural History.

for this pest. A spray of cryolite, 6 pounds in 100 gallons of water, 300 gallons to an acre, was very effective against the first brood but failed to curtail the second well. Dusting with cryolite proved to be unreliable for either brood.

*Blunt-nosed Leafhopper (Ophiola)*. Cryolite, 6 pounds in 100 gallons of water, 400 gallons to an acre, failed entirely as a control for this pest.

*Cranberry White Grub (Phyllophaga)*. Considerable cranberry infestations by this species are found only in bogs that are flooded during the winter and have not been reflooded in late May or June for several years. Apparently such late reflooding interferes with the egg-laying of the beetles enough to serve as a control. Individual grubs of this insect are three times as destructive as those of the cranberry root grub (*Amphicoma*), and they travel around in the soil much more. The cyanide and the flooding treatments used against the root grub are also effective against the white grub. This white grub is always present more or less in the soil of the uplands around the bogs and it attacks the roots of cultivated blueberry plants extensively.

*Cranberry Fruit Worm (Mineola vaccinii)*. Cryolite, 5 pounds in 100 gallons of water, 400 gallons to an acre, was fully effective against the fruit worm. Dusting with a mixture of 60 pounds of talc and 40 pounds of cryolite, at the rate of 60 pounds to an acre, was also effective. Spraying for this insect, in spite of its greater cost, is fully as advisable as dusting, for dusting seems to do more mechanical injury to the crop after the berries have begun to grow than does spraying.

*Colaspis Rootworm (Colaspis brunnea var. costipennis)*. The infestation of this species described in last year's report<sup>4</sup> was kept under observation. The description of the full-grown grubs on June 12 was as follows: Length, about a quarter of an inch. Head pale yellow, the antennae not nearly reaching the tips of the mandibles. Body nearly white, without markings; the back and sides scattered over with simple pale hairs noticeable under a lens. Abdomen not noticeably darkened by its contents; the venter covered with a brush of brown hairs, those at the sides in clusters and larger than those across the middle, the latter arranged in transverse lines; the tip with a considerable prominence, ridged vertically at the end, extending caudad on each side of the anal opening. All the tarsal claws single, simple, slender, and sharply pointed.

This grub is much like that of the cranberry rootworm (*Rhabdopterus*), but its head is somewhat narrower relative to the width of the body than the head of that species.

The grubs all pupated about June 14, the winter water having been removed from the infested area early. The description of the pupa follows: Length about three-sixteenths of an inch. Color waxy white. Rather long, light brown hairs scattered freely over the upper surface of the head, thorax, and abdomen, many of them borne on conical pustules. Under surface of the body without hairs. Tips of the sheaths of the middle and hind legs each with a noticeable spine. Tip of abdomen truncate, with a strong, brown, somewhat curved spine on each side extending caudad; somewhat in front of these spines, a smaller straight spine extending squarely laterad on each side, and in front of this another spine extending caudolaterad.

<sup>4</sup> Mass. Agr. Expt. Sta. Bul. 369:33. 1940.



These pupae waggle the abdomen very freely when disturbed. They are very much like those of the cranberry rootworm (*Rhabdopterus*) in habits, size, appearance, and structure and in the distribution and character of all the hairs and spines described above.

All the *Colaspis* beetles emerged from the pupal condition between the twentieth and twenty-sixth of June.

For comparison with the description of the *Colaspis* grub given above, a description of the full-grown grub of the cranberry rootworm (*Rhabdopterus*) is given here: Length, a little over a quarter of an inch. Head light brown, the antennae not nearly reaching the tips of the mandibles. Body whitish without markings; the back and sides scattered over with simple brown hairs noticeable under a lens. Abdomen not noticeably darkened by its contents; the venter covered with a brush of brown hairs, those at the sides in clusters and larger than those across the middle, the latter arranged in transverse lines; the tip with a rounded light brown plate on each side of the anal opening. All the tarsal claws single, simple, slender, and sharply pointed.

*Cryolite* has come to stay as a cranberry insecticide. About 17,000 pounds of it were used on Massachusetts bogs during the season with generally satisfactory results. It takes four or five days to effect its kill, but it stops worm feeding on foliage very soon. It will be useful mainly against the fruit worm and as a substitute for lead arsenate where that has been used heretofore late in May. The weevil and the black-headed fireworm should soon cease to be troublesome where it is used fairly regularly against the gypsy moth and false armyworm. It doesn't seem to control spanworms as well as arsenate of lead.

*Anhydro Hexitol-Cocoanut Oil Fatty Acid Esters*. Aqueous dispersions of esters of anhydro hexitols and cocoanut oil fatty acids were tried against the cranberry spittle insect, the black-headed fireworm, and the blunt-nosed leafhopper. They failed to control any of these insects to any noticeable extent even when they were used in such strength that they completely destroyed the cranberry inflorescence.

*Prevalence of Cranberry Pests*. The relative general abundance of cranberry pests in Massachusetts in the 1940 season, as judged by general observations and by the opinions of cranberry growers, was as follows:

1. Gypsy moth in Plymouth County about as abundant as in 1939; quite destructive on the outer Cape, but less so than in 1939.
2. Blunt-nosed leafhopper about the same as in 1939.
3. Cranberry fruit worm greatly more abundant than in 1939, more destructive than for many years.
4. Black-headed fireworm about as usual.
5. Firebeetle (*Cryptocephalus*) very much less prevalent than in the last few seasons, only an occasional specimen being found anywhere.
6. Spanworms about the same as in 1939.
7. False armyworm much more generally prevalent than for many years. Blossom worm less abundant than usual. Other cutworms scarce.
8. Cranberry girdler (*Crambus*) and cranberry weevil about as in 1939.
9. Cranberry spittle insect (*Clastoptera*) and tipworm (*Dasyneura*) noticeably more prevalent than in 1939.
10. Spotted fireworm (*Cacoccia*) scattered, but more abundant than usual.

### Control of Cranberry Bog Weeds. (Chester E. Cross.)

*Kerosene.* The water-white kerosenes of five different refining companies were again tested for their vine-burning and weed-killing properties, with results similar to those of 1939: the Atlantic, Colonial and Gulf kerosenes were less harmful to cranberry vines than the others tried; Shell kerosene did more burning than the Shell product of last year. In order of increasing toxicity to vines they stood this year as follows: Atlantic, Gulf, Colonial, Shell, and Cities Service.

The various kerosenes were all about alike as killers of grasses, sedges, and rushes. Colonial and Shell were the most effective on loosestrife.

Studies were made of relative vine burn by kerosene under varying conditions of humidity, sky, time of day, and wind. High relative humidities correlated with severe vine injury; kerosene applied from 11 a. m. to 4 p. m. burned the vines, while applications made the same day from 5 to 9.30 p. m. did no harm. Air currents are intimately associated in this with the prevailing humidity; if the latter is high, winds make the vine burn excessive; if low, they hasten the evaporation of the oil, and the vines are not hurt. Kerosene always reduces the crop when applied after the blossom buds are fully developed.

Applied in small quantities to the bases of the plants, kerosene kills bayberry and sweet gale bushes as it does hoary alders. A heavy spray to the tops of these plants is equally effective.

*Ferric Sulfate.* The injury to cranberry vines, reported by many growers, can be avoided by spreading this chemical evenly and brushing it off from the vines after it is applied. The margin in tolerance between weeds and cranberry vines is rather narrow, and locally increased doses harm the vines. Moisture on the vines at the time of treatment caused much injury. Dry weather after the application makes the chemical more effective in killing weeds and reduces the hazard to the vines. Midday applications are best; late afternoon treatments, even when the vines seem dry, are apt to be harmful.

Ferric sulfate was rather widely used on bogs this year. It proved very effective on horsetail, small ferns, royal fern, hardhack, wool grass (*Scirpus cyperinus*), and spike rush or needle grass (*Eleocharis*) when a small handful was applied at the base of each plant. It works on the root system, killing it completely. The cranberry vines remain unhurt if it is used carefully. It is also effective used early in the season on asters, a broadcast of 15 to 20 pounds to the square rod being advocated. Needle grass can also probably be controlled in this way, though the permanence of its kill is uncertain.

Broadcasts of 20 pounds of ferric sulfate to the square rod killed 90 percent of the rice cut-grass ("sickle grass") even where the drainage was only five inches. As cut-grass infests poorly drained areas mostly, it is hard to control with kerosene. The bog soil should be kept as dry as possible during and after the treatment with ferric sulfate.

Ferric sulfate was effective when applied early in the growing season. Plots treated late in August and in September showed only moderate kills of the weeds, and the vines were hurt in many cases.

*Ferrous Sulfate.* A large number of plots treated in June and July proved that dry applications of ferrous sulfate watered at once with a sprinkling can be far more effective than those left to be dissolved by rain.

A dry broadcast, 30 pounds to the square rod, killed 98 percent of

sensitive ferns; 40 pounds killed the same percentage of feather ferns and about 50 percent of long-leaved asters. Any heavier applications caused serious vine injury.

A solution of ferrous sulfate (1 lb.  $\text{FeSO}_4$  to a gallon of water), tried on wild bean in June, was successful only when 3000 or more gallons were used to the acre. Some tip injury resulted then, but the treated plots were relatively weedless in August when vine recovery was complete. Wild bean had been cut down 90 percent, asters (long-leaved) 60 percent, manna grass (*Glyceria*) and reed canary grass 75 percent, haircap moss 90 percent, and feather and sensitive ferns 70 and 90 percent respectively. Treatments in May with this solution might be as effective in killing weeds, possibly without vine injury.

Iron sulfate solutions of varying concentration and quantity were applied to sensitive and feather ferns. It was concluded that dry applications for these weeds are more feasible.

*Copper Sulfate.* Solutions of this chemical caused some injury when applied the first week in August. The injury was to vine tips and was like the burning noticed on plots sprayed the last week in July 1939. Growers must not use this spray too early in years with a backward growing season.

Copper sulfate solutions are still the only effective treatment for "summer grass" (*Panicum verrucosum*). They burn the grass tops and prevent seeding. It is better to use 20 pounds in 100 gallons of water, at the rate of 400 gallons to the acre, than to use a stronger solution more lightly.

Solutions of copper sulfate were very effective in burning the tops of Joe-Pye weed (*Eupatorium purpureum*). This weed is common on only a few Cape Cod bogs but is a serious pest to many Wisconsin growers.

Copper sulfate, 20 pounds in 100 gallons of water, killed wild bean foliage nearly as well as sodium arsenate spray.

*Paradichlorobenzene.* This chemical, applied early in May with a fertilizer spreader, 600 pounds to an acre, and covered with sand, killed white violets very nicely and seems to be the most promising treatment for them so far found. It did not harm cranberry vines.

*Ammonium Sulfamate and Sulfamic Acid.* Ammonium sulfamate, scattered dry 1200 pounds to an acre, and sulfamic acid, scattered dry 1600 pounds to an acre, killed all weeds and cranberry vines, much as sodium arsenite and sodium chlorate do. They failed, however, to show any useful selective action.

*Ocean Water.* Tests on wild bean in July showed again that ocean water will kill down the weed tops for the rest of the growing season, but it was hard to apply enough to kill the bean without injuring cranberry vines a good deal. About half as many wild bean shoots came up this year on the areas treated with ocean water in July 1939, as were present when the treatments were made.



## COOPERATIVE CRANBERRY INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture, in cooperation with the Massachusetts Agricultural Experiment Station

H. F. Bergman, senior pathologist, Division of Fruit and Vegetable Crops and Diseases, in Charge

**Oxygen Content of Winter Flooding Water in Relation to Injury to Cranberry Vines.** (H. F. Bergman.) Continuing studies made previously, measurements of the oxygen content of the winter flooding water on several bogs were made at weekly intervals from January 22 to March 8, 1940. These bogs were flooded early in December and were under ice from the middle of December 1939 until about March 10, 1940. The oxygen content of the water on all bogs, from the time the first samples were taken until the ice melted, was less than 1 cc. per liter and in some instances was less than 0.5 cc. per liter.

There was no crop on two bogs on which the water was held until about the middle of May. On other bogs the water was withdrawn late in March or early in April and the crop varied from about normal to about one-half. From limited data available, it appears that vines which had produced a large crop are more susceptible to oxygen deficiency injury during the following winter flooding period than are vines which had produced only a small crop, probably because the former have less stored carbohydrates than the latter when placed under winter flood. Vines with an ample carbohydrate reserve are able to withstand an oxygen deficiency in the winter flooding water for a longer time than those with a small supply of stored carbohydrates. One of the bogs on which the oxygen content of the winter flooding water was determined showed no oxygen deficiency injury. This bog had a very light crop in 1939. Two other bogs which had moderately good crops (50-60 barrels per acre) in 1939 showed some oxygen deficiency injury. The injury was greater in more deeply flooded areas on these bogs, which were probably also areas of greater or more prolonged deficiency. The injury was manifest in the retardation in the development of flowering uprights and of the flowers themselves and in reduced fruit production, but there was very little leaf drop.

The fourth (State) bog showed the most severe oxygen deficiency injury on an area which had produced a relatively heavy crop (75-80 barrels per acre) in 1939. The injury caused a decided retardation in the development of new uprights and of the flowers and a marked decrease in yield, as well as much leaf drop in areas in which injury was most severe.

The reduction in yield was due mainly to the failure of flowers to set fruit, but very dry weather during the late summer also contributed by reducing the size of the berries. The number of flowers produced was normal with an average of four to five per upright in each of the main three varieties on the bog, Early Black, Howes, and McFarlin. The percentage of flowers setting fruit was as follows: Early Black, Section 5, 12.8; Early Black, Section 14, 15.5; Howes, Section 13, 10.2; McFarlin, Section 13, 12.1. A normal set in these varieties would average 30 to 35 percent.

Studies are being continued on the relation between the amount of

stored carbohydrates during late fall and early winter and the probability of injury to vines from oxygen deficiency during the winter flooding period, and also on the relation of oxygen deficiency during the winter flooding period to the setting of fruit during the following summer.

**Spraying Experiments for the Control of Rosebloom.** (H. F. Bergman.) The following spray mixtures were applied June 20, 1940, on duplicate plots at the rate of 250 gallons per acre: bordeaux 40-4-100 and 8-8-100 each with 2 pounds of rosin-fish oil soap; basic copper arsenate 5-100 and 6-100; and yellow cuprocid 1½-100 and 2-100.

Bordeaux 10-4-100 and basic copper arsenate 5-100 and 6-100 gave complete control. Six days after the plots had been sprayed only a few living diseased shoots were found on plots sprayed with any one of these mixtures. Bordeaux 8-8-100 was considerably less effective than the 10-4-100 or than the basic copper arsenates. Yellow cuprocid 1½-100 and 2-100 were still less effective than bordeaux 8-8-100 and gave probably not more than 50 percent control.

**Spraying Experiments for Cranberry Fruit Rot Control.** (H. F. Bergman.) Spray tests were run on three bogs. The plots, the number of applications, and the time and rate of application were the same as in 1939 (See Bulletin 369, p. 40). The results are given in the table.

TABLE 1. THE EFFECT OF SOME FUNGICIDES ON THE CONTROL OF ROTS ON FOUR DIFFERENT CRANBERRY BOGS IN MASSACHUSETTS IN 1940

Bog and Treatment	Number of Plots	Average Percentage of Rot		
		Oct. 1	Nov. 1	Dec. 1
State Bog S 8				
Bordeaux 10-4-100 .....	3	0.4	2.5	6.2
Cuprocide-bentonite 3-4-100 .....	2	0.2	2.0	5.4
Copper arsenate (basic) 4½-100 .....	3	0.3	2.4	8.1
None (check) .....	5	0.5	3.3	10.3
State Bog S 14				
Bordeaux 10-4-100 .....	3	0.3	2.1	7.5
Yellow cuprocide 1-100 .....	3	0.3	2.9	9.4
None (check) .....	4	0.5	4.6	11.5
Bog No. 3				
Bordeaux 10-4-100 .....	3	1.0	7.0	33.5
Cuprocide-bentonite 4-5-100 .....	3	0.6	6.8	29.2
Yellow cuprocide 2-100 .....	3	1.0	9.7	40.9
Copper arsenate (basic) 6-100 .....	3	1.3	12.0	49.4
None (check) .....	5	1.4	12.0	40.0
Bog No. 9				
Bordeaux 10-4-100 .....	3	3.1	4.7	8.9
Yellow cuprocide 1½-100 .....	3	4.0	6.6	13.9
Copper arsenate (basic) 6-100 .....	3	3.7	5.1	9.0
None (check) .....	5	6.1	10.9	27.0

The extent to which fruit rots were controlled on different bogs varied widely, apparently according to the density of vine growth. The best control was obtained on bog No. 9 on which the vines are least dense and the poorest on bog No. 3 which has the densest vines. There may be some other factor or factors involved, as somewhat better results have

been obtained on bog No. 3 in other years; although this bog has been found, through experiments extending over a period of years, to be one on which the control of rot is very difficult. Judging from results obtained this year on bog No. 3, cuprocide-bentonite 4-5-100 appeared to be slightly superior to bordeaux 10-4-100 for rot control. Cuprocide-bentonite 3-4-100 on section 8 of the State Bog gave as good control of rots as did bordeaux 10-4-100. Yellow cuprocide 1-100 on section 14 of the State Bog had little effect in reducing rot. Basic copper arsenate  $4\frac{1}{2}$ -100 also appears to be ineffective since on section 8 of the State Bog it reduced the rot, up to December 1, very little in comparison with untreated plots. Yellow cuprocide  $1\frac{1}{2}$ -100, as shown by the results on Bog No. 9 where fruit rots were controlled most effectively by bordeaux 10-4-100 and by basic copper arsenate 6-100, seems definitely to be less effective than bordeaux for rot control. The results obtained with yellow cuprocide 2-100 and with basic copper arsenate 6-100 are not conclusive. Basic copper arsenate on bog No. 9 gave as good control of fruit rots as did bordeaux 10-4-100. On bog No. 3 neither yellow cuprocide 2-100 nor basic copper arsenate 6-100 reduced the amount of rot, up to December 1, as compared with that in berries from nonsprayed plots and basic copper arsenate appears even to have increased it.

**Blueberry Disease Investigations.** (H. F. Bergman.) Severe defoliation and dying-back of twigs and small branches, and sometimes also of main branches, was observed in two blueberry plantings in each of which from six to twelve bushes were affected. *Phomopsis* was isolated from material from both plantings. This fungus heretofore, except in the case of two bushes in the State Bog planting reported last year, has not been known to cause greater injury than the killing of the tips of twigs.

## DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

**The Cacao-Red or Tannin-Like Substances in Commercial Cocoa Powders.** (W. S. Mueller cooperating with Control Service—J. W. Kuzmeski and A. F. Spelman.) Since it seemed possible that the cacao-red (tannin-like substances) in cocoa might be one cause of the observed decrease in growth rate of white rats when excessive amounts of cocoa were added to milk, the first step in the investigation was to analyze commercial cocoa powders for cacao-red. Authorities do not agree on the chemical composition of cacao-red and most of the methods of analysis are rather crude and somewhat unreliable. Ulrich's method was used in this study because it is the generally accepted method. By this method the amount of cacao-red in cocoa is reported as weight of the insoluble iron compound. Sixteen samples of commercial cocoa powders have been analyzed and values for the iron precipitate ranged from 2.62 to 15.59 percent, with an average of 10.83 percent. In general, unprocessed cocoa was found to have a higher cacao-red content than the processed cocoa.

It was thought that Ulrich's method could be improved by investigating the composition of the insoluble iron compound. Accordingly, the Control Service has analyzed the insoluble iron precipitate obtained from various samples of cocoa powder. The following analysis is typical for a number of samples:



	<i>Percent</i>
Ash .....	9.6
Fe in ash .....	38.8
PO <sub>4</sub> in ash .....	56.1
FePO <sub>4</sub> in ash .....	89.0
Fe <sub>2</sub> O <sub>3</sub> in ash .....	8.2

Further analyses are necessary before definite conclusions can be drawn. However, the results to date indicate that values obtained for cacao-red by Ulrich's method are somewhat high and that this error could be reduced by ashing the insoluble iron compound and subtracting the weight of ash from the weight of the iron precipitate.

Experiments are under way to determine whether or not there is a correlation between the amount of cacao-red in cocoa and the digestibility of the chocolate milk.

**The Effect of Various Methods of Pasteurization on Chocolate Milk.** (W. S. Mueller and L. D. Lipman.) The methods of pasteurization which have been studied are the Electropure process at 162° F. and ordinary vat pasteurization at 143°F. for 30 minutes and at 160°F. for 15 minutes. Preliminary conclusions from this study are as follows:

1. The Electropure method of pasteurization gave smaller cream volumes than the vat process. When an unstabilized chocolate milk was used, sedimentation was greater in the Electropure-processed milk than in the vat-processed milk. On the other hand, when a stabilized chocolate milk was used, no marked sedimentation occurred in either process; however, the vat-pasteurized milk tended to show a very slight sediment of a few small particles, whereas the Electropure processed milk showed no sediment.

2. The method of pasteurization had no effect on the flavor except that the vat process at 160°F. for 15 minutes caused a slight cooked flavor in the finished product.

3. The Electropure process gave lower phosphatase results than the vat process except when the vat pasteurizing process was changed to 160°F. for 15 minutes. In such cases the vat process gave lower phosphatase results.

4. The vat method of pasteurization tended to cause a greater percentage reduction in bacteria count than the Electropure method. This difference was more noticeable when stabilized chocolate milks were processed, and especially when the vat process was changed to 160°F. for 15 minutes.

5. The Electropure process tended to produce a more viscous product, especially when the chocolate milk contained a stabilizer.

**The Bacteriology of Chocolate Milk, Chocolate Syrup, and Cocoa Powders.** (W. S. Mueller in cooperation with Department of Bacteriology.) For further information on this study, refer to report by Department of Bacteriology.

**Improving the Flavor and Keeping Properties of Milk and Some of Its Products.** (W. S. Mueller and M. J. Mack.) The antioxidative properties of the following sugars have been tested by adding them to susceptible milk: raw cane, raw cane treated with filter cell, etc., refined cane, raw beet, intermediate beet, pure granulated beet, beet molasses, refined blackstrap, corn sugar, and cane sugar with added extract of cereal flour. No

significant differences were noted between the different kinds of sugars. However, considerable differences were noted between the refined and raw sugars. The refining process seems to destroy some of the antioxidative properties of the sugar.

Cocoa shell was found to contain an antioxidative substance nearly as potent as that obtained from the cocoa powder. Dried extracts of cocoa shell proved to be an effective antioxidant when added to milk. An attempt is being made to isolate the antioxidant from cocoa powder and cocoa shell.

It was found that puffed oat flour goes into solution more readily and has slightly better stabilizing properties than ordinary oat flour. The antioxidative properties of puffed oat flour were equal to those found in ordinary oat flour when these substances were added to susceptible milk. Puffed oat flour, however, imparted a stronger flour taste to both ice cream and milk than ordinary oat flour.

**The Effect of Various Antioxidants on the Behavior of Gelatin or Other Stabilizers in Ice Cream.** (W. S. Mueller.) Today some ice cream manufacturers are adding antioxidants to ice cream mix in order to improve the flavor of their product. This practice has brought up a new problem, for some antioxidants also possess stabilizing properties and may cause overstabilization of the ice cream unless the amount of stabilizer ordinarily used is decreased. Several antioxidants were found to affect the action of gelatin in ice cream. Some ice cream manufacturers want a product which combines the antioxidant with the stabilizer. This brings up another problem for the amount of some antioxidants which is necessary to protect the flavor would raise the stabilizer content in ice cream above maximum amounts set by some states. Oat flour used with gelatin is an example. Oat flour has been found not to interfere with the efficiency of gelatin in ice cream. Studies are being continued to find an antioxidant that is potent enough so that only a small quantity would be used and that would also combine with the gelatin.

**Cooperative Study with the American Dairy Science Association Committee on Methods for Determining the Curd Tension of Milk.** (W. S. Mueller.) The major factors studied during the past year were: the stability of the coagulant (N.1 HCl + .45 percent U.S.P. 1:3000 dry pepsin) when stored away from light in a refrigerator; design and sharpness of knife; design of coagulating vessel; effect of covering the coagulating vessel during coagulation of the milk; speed of knife or vessel; and feasibility of specifying surface readings instead of continuous or secondary readings.

Results so far obtained indicate that the coagulant need not be made fresh daily, and if properly handled may retain its activity for one week. A knife of smaller total diameter but with the same lineal cutting edge is being compared with the knife furnished with the Submarine Signal and American Curd-O-Meter instruments. The former knife gives readings which are approximately 15 percent lower than those obtained by the use of the standard knife. Covering the coagulating vessel increased the surface or maximum curd tension reading but had little effect on the secondary or continuous reading. No significant differences were noted in deviations from the average curd tension when surface and continuous readings were compared.

**The Use of Corn Syrup Solids in Ice Cream and Ices.** (M. J. Mack and L. R. Glazier.) A new sweetener for use in frozen dairy products has recently been made available—dry corn syrup solids. This product results from the dehydration of corn syrup to a stable, white amorphous powder which looks like confectioners sugar. The approximate analysis of corn syrup solids is: dextrose 21 percent, maltose 33.2 percent, dextrans, 43.3 percent, and moisture 2.5 percent. Since this sweetener is less expensive than sucrose, the partial replacement of sucrose by corn syrup solids is desirable, provided the quality of the finished product is not lowered by the change.

Sugars have two principal functions in frozen dairy products: one to contribute sweetness, and the other to improve body and texture. Sucrose is sweeter than the corn sugars. However, certain combinations of sucrose and corn syrup solids improve the body and texture more than an equivalent weight of sucrose. The relative desirability of the ice creams made in this study was determined by consumer preference tests. The consumers did not know the identity of the samples they were judging.

The replacement of 20 percent of the sucrose of ice cream by corn syrup solids did not make a perceptible change in sweetness; but when the replacement was 25 percent, some consumers recognized a slight lowering of sweetness, although the majority did not. As the replacement of sucrose by corn syrup solids progressed above this amount, more and more of the judges noticed a loss in sweetness of ice cream. The use of corn syrup solids improved the body and texture of ice cream; this was noticed by at least 70 percent of the consumers. The final preference of the majority of the judges was for the ice creams in which 20 or 25 percent of the sucrose was replaced by corn syrup solids, rather than for those containing sucrose alone. A somewhat higher replacement of 33 1/3 percent of corn syrup solids for sucrose was preferred in ices and sherbets.

There are several other effects produced by corn syrup solids in ice cream. When this sweetener replaced 25 percent of the sucrose, the mix viscosity was increased about 10 percent and the titratable acidity was increased very slightly, but the stability of the proteins of the mix remained unchanged. The replacement had no adverse effect on the whipping ability of the ice cream mix.

The use of corn syrup solids, in combination with sucrose, improved noticeably the body and texture of ices and sherbets, as well as ice bars. The formation of a surface crust of crystallized sucrose, which is often troublesome with ices and sherbets, was prevented by the replacement of one-third of the sucrose ordinarily used in these products by corn syrup solids.

**The Appearance of Melted Ice Cream.** (M. J. Mack.) When ice cream is scored, using the score card approved by the American Dairy Science Association as a guide, the melting appearance of the product is considered. Ice cream should appear smooth and creamy when melted; undesirable defects listed on the score card are "curdy," "wheys off," and "does not melt."

The melting appearance of ice cream is a factor of importance, yet it has been given little attention in research. Defects in melting appearance have been attributed to a partial loss in stability of the proteins of ice cream, caused by acidity development, unusual proportions of the minerals present, or faulty homogenization. Marked defects in melting ap-



pearance are undoubtedly caused by factors which affect the stability of the proteins, but this explanation does not seem to be true when the defects are slight.

A number of factors, in addition to those already mentioned, have been found to affect the appearance of melting ice cream, such as the composition of the mix. High butter fat content, low sugar concentration, and an excessive amount of stabilizer may all contribute to the difficulty. The kind of stabilizer used is also important, since stabilizers vary in their effect on the melting characteristics of ice cream. Fast freezing and hardening are both necessary in order to secure a smooth melting appearance. Dipped ice cream has a more desirable melting appearance than packaged ice cream, which shows that the percentage of overrun is also involved.

Ice cream which has desirable melting characteristics can be secured by the use of good ingredients, properly proportioned. The homogenization temperature and pressure must be satisfactory for the composition of the ice cream, and rapid freezing and hardening are also essential.

**A Study of the Efficiency and Practicability of the Paper Milk Bottle.** (J. H. Frandsen and M. A. Widland.) As far as the study went, no off-flavors seemed to be due to the paper bottles.

**A Comparison of the Electropure and Vat Methods of Pasteurization.** (Leo D. Lipman, J. H. Frandsen, and H. G. Lindquist.) Split batches of raw milk were pasteurized in (a) the Electropure at 162° F. for 16 seconds and in (b) a spray vat at 143° for 30 minutes. Preliminary conclusions from this study are:

1. The reduction in the vitamin C content of milk was less rapid in Electropure-pasteurized milk than in raw or vat-pasteurized milks.
2. The Electropure method gave better (i.e. lower) phosphatase results than the vat method.
3. Pasteurization by both methods decreased the cream volume. While the Electropure method tended to give a greater cream volume than the vat method, the difference was so small that no definite conclusions can be drawn as to which of the two methods of pasteurization results in a lesser decrease in cream volume.
4. There was no significant difference in efficiency of bacterial reduction between the vat and Electropure methods of pasteurization.
5. Electropure-pasteurized milk became oxidized less rapidly, less frequently, and to a lesser degree than vat-pasteurized milk. A cooked flavor was found more often and was more pronounced in vat-pasteurized milk than in Electropure-pasteurized milk.

## DEPARTMENT OF ECONOMICS

Alexander E. Cance in Charge

**Land-Use Problems in Massachusetts in Relation to a Balanced Program of Land Utilization.** (David Rozman.) The work on this project continued with the analysis of land-use factors in the light of economic and social conditions as they affect individual communities in rural areas. The program of land-use classification advanced to a point where detailed information is now available for over 300 rural towns of the Commonwealth. This includes the analysis of interrelationships between basic factors, as movement of population, tax rate, types of soil, land use and cover, road conditions, and other facilities and improvements in rural areas.

During the past year especial emphasis has been placed on the analysis of types of farming and the degree of diversification prevailing in various sections of the State. The study of these facts has been brought into prominence in connection with the accelerated defense program and the possibility of changes in the farming organization. These are expected to develop as a result of the shortage of farm labor and the changing level of prices for both farm products and the products purchased by the farm operators.

In Bristol County, where a complete analysis of the farm enterprises was carried out, a considerable amount of diversification is indicated. Out of a total number of 1,259 commercial and semi-commercial farms investigated, 647 or 51 percent had two or more farm enterprises; and of these, 205 farms, or 16 percent of the total number, had three or more different enterprises. The farms with only one enterprise numbered 612 or 49 percent of the total. The degree of diversification in commercial and semi-commercial farms compares favorably with that of farms operated on a self-sufficient or a part-time basis. The investigation and analysis carried out for the latter in the same county indicate only 33 percent of the total number of units having two or more enterprises.

It has been generally recognized that, whatever changes in farm organization are brought about as a result of the new influences, it is important to maintain a certain amount of self-sufficiency and diversification of enterprise to meet the conditions after the present acceleration of business activity is terminated.



Left: Two Sunflower Plants per Hill—Crop Almost Complete Failure.  
Right: One Sunflower Plant per Hill—Strong Stalk with Large Seed Head.





The Effect of Increasing Dosages of Arsenic ( $\text{As}_2\text{O}_3$ ) with a Constant Amount of Organic Matter on the Growth of Buckwheat.

D1—control; D1'—organic matter alone; D4—1500 p.p.m. of arsenic; D4'—1500 p.p.m. of arsenic with organic matter; D5—2000 p.p.m. of arsenic; D5'—2000 p.p.m. of arsenic with organic matter.



Hog Cranberry Used to Control Slope Erosion on Sandy Hills and Roadside Embankments on Cape Cod

## DEPARTMENT OF ENGINEERING

C. I. Gunness in Charge

**Cranberry Storage Investigation.** (C. I. Gunness, H. J. Franklin, and C. R. Fellers.) Cranberries from the 1940 crop were stored in a modified atmosphere. Berries were stored in air-tight steel cabinets, the covers being made tight by a water seal. Two rooms were operated: one at 35° and the other at 45°. Two cabinets were placed in each room. In one cabinet in each room an atmosphere of 5 percent carbon dioxide and 2 percent oxygen was maintained; and in the other, 10 percent of carbon dioxide and approximately 11 percent oxygen was maintained. The excess in carbon dioxide above 5 percent was removed by passing the air through a solution of sodium hydroxide. The deficiency in oxygen was supplied by ventilation. The 10 percent concentration of dioxide was maintained by ventilation.

The results of the experiment were not satisfactory. The means provided for removing the water given off by respiration were found to be inadequate. As a consequence the berries were wet when the cabinets were opened. Additional moisture was admitted to the cabinets by ventilation because the air for ventilation was drawn from an anteroom which was warmer than the storage rooms. The conditions would not exist in an actual storage as the refrigerating coils would tend to remove excess humidity through frosting of the coils.

Berries stored at 35° in 5 percent carbon dioxide and 2 percent oxygen showed practically the same loss as berries stored in air at the same temperature. The other lots of berries stored in a modified atmosphere showed considerably greater loss than those stored in air; but all lots were so wet that the excessive losses could be ascribed to the moisture rather than to the condition of the atmosphere.

Berries stored in the modified atmosphere showed less coloring than those stored in air, which would indicate less ripening in the modified atmosphere.

**Apple Storage Investigation.** (C. I. Gunness in cooperation with Department of Pomology.) A small room in the cold storage plant at the State College was lined with sheet iron and made gas tight for a trial in the storage of McIntosh apples in a modified atmosphere. A 5 percent concentration of carbon dioxide is maintained in this room, the excess being removed by a sodium hydroxide scrubber. Apples were placed in storage in September and no results are available until the storage is opened in the spring.

**Frost Protection on Cranberry Bogs.** (C. I. Gunness.) The wind machine as a means of protecting cranberry bogs against frost was given further trials, both in the spring and fall of 1940. Only a limited number of trials could be made each season and the results indicated that with a temperature inversion of 7°, protection was given over a circular area of 300-foot radius.

**Poultry House Investigation.** (C. I. Gunness and W. C. Sanctuary.) An investigation of the operation of electric brooders in colony houses was carried on during the past winter. Identical brooders were used in a conventional uninsulated brooder house, an insulated house, and an uninsulated house in which soil cable was placed on the floor for drying the litter. The litter in the first house was considerably wetter than that

in the other two houses; and in the house provided with soil cable, the litter was drier than that in the insulated house. At the end of the trial the moisture in the litter in the uninsulated house was 48 percent, in the insulated house 37 percent, and in the house equipped with soil cable, 30 percent. Chick growth and feathering were practically identical in the three houses.

More electric current was used for the soil cable than was considered practical.

The work will be repeated during the coming season and an effort will be made to reduce the current consumption by rearrangement of the heating cable and reduction of the heating time.

## DEPARTMENT OF ENTOMOLOGY

Charles P. Alexander in Charge

**Investigation of Materials which Promise Value in Insect Control.** (A. I. Bourne.)

*Oil Sprays for Dormant Applications.* (A. I. Bourne.) The close of the winter season was marked by much cold weather and snowfall considerably in excess of normal during March, while April was so unseasonably cold and wet that orchard and shade trees remained dormant throughout most of the month and seasonal development was very slow until May. Snowfall of 2.5 inches on April 12 and 13 and 4 inches on the 21st and 22d with accompanying low temperatures combined to hold the trees dormant but furnished very unfavorable conditions in the orchards for dormant applications of DN oils and similar sprays. It was difficult to operate spray equipment under such conditions, and the snow and low temperatures after applications of oils increased the danger of injury to sprayed trees.

The cooperative project with the Dow Chemical Company on a study of the value of DN sprays involved the use of different concentrations of dinitro-ortho-cyclo-hexylphenol (DNOCHP) powders dissolved in varying strengths of a commercial oil emulsion. Similar studies were made of dinitro-orthocresol (DNOC) and dinitro-phenol (DN-Phenol) compounds. These mixtures were tested in the college orchard for their effectiveness against overwintering eggs of European red mite and orchard plant lice. The infestation of European red mite in the experimental blocks was negligible, and the number of overwintering eggs of aphids was very much smaller than in 1939. The sprays were applied April 11 while the trees were in strictly dormant condition. Although there was a fall of 2.5 inches of snow the following day and an accompanying drop in temperature to 20° F., no injury resulted nor was any retardation in bud development noted. The DNOCHP-oil emulsion and DNOC-oil emulsion sprays gave practically perfect kill of aphid eggs. Unsprayed checks showed an average of 530 lice per 100 clusters on Baldwin and 890 per 100 clusters on McIntosh trees. On sprayed trees the number of lice was seldom greater than 1 per 100 clusters. The DN-Phenol combinations were noticeably less effective but gave good commercial control.

Solutions of  $\frac{1}{2}$ ,  $\frac{3}{4}$ , and 1 percent of DNOCHP in oils of 52, 87, and 108 sec. Saybolt viscosity, applied while the plants were in strictly

dormant condition, caused no injury on various types of deciduous ornamentals or on white spruce, arborvitae, Irish juniper, and red pine. These oils at 4 percent strength applied to lilac caused no injury or retardation of development and gave excellent control of oystershell scale.

Tests of commercial DN sprays and the DNOCHP-oil emulsion on estates and in orchards in Plymouth County, in cooperation with Mr. R. E. Huntley, again showed control of rosy apple aphid in direct proportion to thoroughness of coverage. Troublesome infestations of oystershell scale and pear psylla were also controlled. Aphid attack was also checked on various species of *Viburnum*, a group which suffers severe curling, dwarfing, and distortion of foliage from even a light attack. The sprayed shrubs were very conspicuous in midsummer because of their flat, normal foliage in contrast to unsprayed checks in the vicinity.

One significant result of the season's work in that region was the condition of one orchard in which commercial DN sprays had practically eliminated rosy aphid in 1939. No spray, dormant or otherwise, was applied there in 1940. Inspection of the orchard in midsummer showed serious injury to the foliage and distorted terminal growth, and the fruit was largely "aphis apples." Subsequent examination at time of harvest showed the fruit of all varieties in this orchard to be worthless.

*Summer Sprays for Apples.* (A. I. Bourne in cooperation with Departments of Pomology and Botany.) Tests were made of certain variations of the standard spray program to determine the value of recent tendencies in spray practices and to contrast the liquid lime-sulfur with wettable sulfur for scab control. Tests of the present standard program were made to serve as the basis of comparison; the standard program with the addition of a mid-blossom application of wettable sulfur, without arsenicals; and the standard program without the use of lime in the cover sprays. Throughout the season these were contrasted with a program of wettable sulfur with the addition of lime in the cover sprays and a similar schedule with lime but no sulfur in the cover sprays. Lead arsenate was used at a dosage of 3 pounds per 100 gallons in the pink and 3d cover sprays; 4 pounds in the calyx and 1st and 2d cover sprays, and 2 pounds in the 4th cover spray. In the standard program lime-sulfur was used at the rate of  $1\frac{1}{2}$  gallons per 100. The wettable sulfur was applied at the rate of 7 pounds per 100 gallons. The pathologist found scab appearing on the check trees on May 22. It increased to the point where most of the leaves and much of the fruit were infested by late June. A light infection of scab appeared on McIntosh trees in the sprayed plots during the first half of June following the prolonged rainy period in late May. Only a slight amount of additional scab infection was observed in any of the sprayed plots during the remainder of the season.

In all plots where lime-sulfur was used, its typical injury was noted, especially following the pink and calyx applications. Foliage which appeared after those sprays, however, showed no such injury, nor was any injury noted on the foliage in the plots where only wettable sulfur was applied.

Examination of the fruit at harvest showed a considerable amount of russetting in the plots sprayed with lime-sulfur. This was particularly conspicuous in the plot where lime was omitted in the cover sprays. No russetting was noted in the plots which received wettable sulfur. The



McIntosh crop showed very little scab either in the lime-sulfur plots or where wettable sulfur was used in a complete season's program, although it was much more prevalent where sulfur was omitted and only lime was used in the cover sprays. Scab was found on 61 percent of the fruit from unsprayed trees. The record showed little or no significant difference between any of the programs followed, in the matter of relative control of insect pests.

**Control of Striped Cucumber Beetle.** (W. D. Whitcomb, Waltham.) Unfavorable weather conditions resulted in very poor growth of melons and cucumbers in the experimental planting at Waltham in 1940. Beetles did not appear in appreciable numbers until after July 1 and were less abundant than normally at all times. Of the 3029 beetles recorded on 70 hills each of cucumbers and melons, 82.8 percent were on the cucumbers.

In these experiments, eight applications were made between June 14 and July 18, the treatments being applied when considered necessary rather than at regular intervals.

Under these conditions, nine of the eleven materials used reduced the number of beetles on the plants 90 percent or more and three of them gave 100 percent protection on the melons.

Both rotenone dusts and calcium arsenate dusts were effective in reducing the beetle population, the most effective materials being a commercial copper-rotenone dust and a homemade calcium arsenate-fibrous talc dust. Other satisfactory dusts were a commercial stabilized rotenone dust; a commercial calcium arsenate-red copper oxide dust; copper oxychloride-pyrophyllite talc 1-14; rotenone-talc (.75 percent rotenone), home mix; and calcium arsenate-pyrophyllite talc 1-14. Calcium arsenate-monohydrated copper sulfate-lime 10-20-70 gave good protection against the beetles but caused slight to moderate foliage injury. A tobacco-pyrethrum dust was relatively ineffective and had very little repellent action. An experimental derris spray burned the vines so badly it was discontinued after three applications.

A direct comparison between fibrous talc and pyrophyllite talc as a carrier for calcium arsenate resulted in a 5 percent advantage for the fibrous talc, but this slight advantage is not highly significant.

**Control of Cabbage Maggot.** (W. D. Whitcomb, Waltham.) Because of the cold, wet weather early in the season, the first eggs of the cabbage maggot were not found until May 10, the same date as in 1939, and the latest date in the ten years that records have been made.

The field infestation at Waltham was moderately heavy, averaging 68 percent; but the growing conditions for cruciferous crops were extremely favorable, and in spite of this injury about 53 percent of the untreated plants produced large or medium heads. Only 22 percent of the heads were worthless where no treatment was applied, compared to 49 percent in 1939.

Under these conditions, liquid treatments consisting of corrosive sublimate solution (1 ounce in 10 gallons of water) and calomel-gum arabic suspension (4 ounces calomel and  $3\frac{3}{4}$  ounces gum arabic in 10 gallons of water) gave perfect commercial control of the maggot, and produced 70 to 80 percent large or medium-sized heads.

Because of the cold weather, an application made May 18 (8 days

after the first eggs were found) was slightly more effective than a treatment applied May 11 when the first eggs were found.

Calomel-talc dust (4 percent calomel) applied at the same time as the liquid treatments was very effective and produced 80 to 90 percent large and medium heads, being much more satisfactory than in previous seasons.

Root treatments at transplanting were less effective than in 1939 providing 70 to 90 percent control and producing 60 to 80 percent large and medium heads. Pure calomel dusted on the roots gave perfect commercial control of the maggots but produced 36 percent small heads, the greatest number of any treatment, indicating some plant injury.

A direct comparison between fibrous talc and pyrophyllite talc as a carrier for 25 percent and 50 percent calomel used as root treatments favored the pyrophyllite by 10 percent, both in maggot control and in the production of large and medium-sized heads.

**Control of Squash Vine Borer.** (W. D. Whitcomb, Waltham.) Although the emergence of the squash vine borer moths was 10 days later than normal, the field infestation of 7.45 borers per vine in the experimental field of Blue Hubbard squash at Waltham was the heaviest that has occurred in the last five years.

Experimental control treatments using three dusts and three sprays were applied July 10, 18, 24 and 31. The dusts were applied with a hand duster. For applying the sprays, a hand wheelbarrow sprayer at about 100 pounds pressure was used for the first treatment and a power sprayer at 250 pounds pressure for the other applications.

In spite of the heavy infestation, rotenone-talc dust, a spray of nicotine sulfate 1-500 plus oil emulsion 1 per cent, nicotine sulfate spray 1-250, and copper-rotenone dust all reduced the number of borers per vine 79 percent or more. The differences between these treatments were insignificant, but the greatest protection was obtained from the rotenone-talc dust (.75 percent rotenone) and the spray of nicotine sulfate 1-500 plus oil emulsion 1 percent, with 83.22 and 82.96 percent reduction respectively. A commercial calcium arsenate-copper oxide dust and a commercial rotenone extract spray were not effective.

Yields in the experimental planting were very low owing to unfavorable growing conditions and to a late infection of bacterial wilt. Under these conditions the best yields were obtained where a commercial copper-rotenone dust and a commercial calcium arsenate dust were applied, and it was apparent that the yield was improved more by the fungicidal action of the copper than by maximum control of the squash vine borer.

**Control of Onion Thrips.** (A. I. Bourne.) Unusually cold, wet weather in April and throughout most of May delayed both planting and germination of onions. In the experimental plots the plants were very late in appearing and made very slow growth until well into July. The abnormally cold, cloudy weather in late June and early July also delayed the appearance of thrips and retarded their development. Many fields of set onions were practically free from thrips up to mid-July when the sets were pulled. The abrupt appearance of hot weather in late July provided conditions more favorable for both the growth of the seed onions and the increase of thrips. In the 10-day period from July 21 to 31, the daily temperature reached 83° F. or higher, and during the 5-day period from

July 26 to 30 the temperature was 90° to 94°. Relatively high humidity accompanied this period of high temperature. Blast appeared in the experimental plots in early August and caused the premature death of the plants. Plants never reached normal height and but few of them bottomed out. Thrips, on the other hand, increased rapidly during late July and early August, scarred the leaves badly, and hastened the effect of blast on the plants.

Field tests were made of a fixed nicotine and SS3 spreader, nicotine sulfate and soap, dual-fixed nicotine and Nufilm spreader, derris (4 percent rotenone) and Ultrawet, derris and Nufilm spreader, and flaked naphthalene which was applied to the soil along the rows.

The fixed-nicotine spray gave good initial control and showed marked residual effect. Derris with Nufilm spreader gave excellent kill and reinfestation was slow. The results were better than when derris was used with Ultrawet as a spreader. Dual-fixed nicotine was not effective. Naphthalene flakes gave too uneven results to be dependable. The nicotine sulfate and soap again proved the most effective of any combination in its initial action, but its residual effects were not so pronounced as those of derris. The early death of the plants, due to blast, before onions were formed made any records on relative yield impossible.

**The Spray Residue Problem.** (A. I. Bourne.) Effective August 10, the federal spray residue tolerance for apples and pears shipped within the jurisdiction of the Federal Food, Drug, and Cosmetic Act were raised. The tolerance on arsenic as  $\text{As}_2\text{O}_3$  was raised from .01 to .025 grains per pound of fruit, and that on lead as  $\text{PbO}$  from .025 to .05 grains per pound. This ruling does not apply to fluoride compounds, on which the tolerance of .02 grains per pound is still in force. Neither does the present ruling extend to other food commodities than apples and pears.

The newly defined limits of tolerance are based on extensive studies by the Public Health Service and upon the recommendations of that body. This action brings a great measure of relief to many growers who have been confronted with increasing demands for more extensive spray programs to cope with increasing abundance of major pests such as apple maggot and codling moth, in the face of more and more stringent enforcement of regulations on tolerance.

Through the cooperation of the Chemistry Department, analyses of samples of McIntosh from the experimental orchards showed both lead and arsenic residues to be well below the present requirements. Samples from plots receiving the standard schedule of lead arsenate and lime-sulfur in pre-blossom and calyx applications and lead arsenate and wettable sulfur in the cover sprays showed the presence of .006 grains of  $\text{As}_2\text{O}_3$  and .011 grains of  $\text{PbO}$  per pound of fruit. Fruit from plots receiving lead arsenate and wettable sulfur throughout the season showed .004 grains of  $\text{As}_2\text{O}_3$  and .011 grains of  $\text{PbO}$  per pound. Lead arsenate at dosages of 4 pounds (2d cover), 3 pounds (3d cover), and 2 pounds (4th cover) per 100 gallons was applied on June 28, July 9, and July 22, respectively. The fruit was harvested September 27 and 28. During this period there was very slight rainfall, especially in August and September when the combined precipitation for the two months was less than half the normal. Even under these conditions the margin of safety was such that no washing or wiping of fruit was necessary to meet the present tolerances.

Studies of the value of fixed nicotine in late-season applications for codling moth control, as a supplement to the present spray schedule, were continued in the same commercial orchard as in 1939. Codling moth was reduced to such low proportions in 1939 that banding was discontinued in 1940. Two applications of fixed nicotine were made in addition to the regular schedule: the first in late July in substitution for the regular 4th cover spray, and the second in mid-August.

Based on the examination of McIntosh at harvest, codling moth damage was reduced to 1.09 percent on trees in the center of the orchard, and to 3 percent on border trees exposed to migration from nearby orchards. Similar records of Northern Spy showed 2.6 percent injury on trees in the center of the block and 4.7 percent on marginal trees. The damage on Rhode Island Greening was reduced to 1.4 percent. The control secured on Northern Spy was of particular interest. In 1936 codling moth injury to fruit in that block was estimated at 75 to 80 percent of the crop and was the principal reason for undertaking the test in that orchard. This was the first opportunity of checking the value of the control program on that variety, since Northern Spy is a biennial bearer and the crop of 1938 was strewn about promiscuously by the hurricane of that year.

**Apple Maggot Control.** (A. I. Bourne and W. D. Whitcomb.) Inspection of fruit at harvest and reports from growers indicate that very generally over the State this pest was somewhat more abundant than in 1939 and appears to be building up an infestation to serious proportions. Several factors have produced conditions favorable for such increase. In 1937, as a result of low prices, many growers failed to harvest much of the early-maturing fruit and neglected to dispose of dropped apples promptly. In the following year the hurricane disrupted normal harvesting of the fruit and much of it was left in the orchards. In 1939, as a result of the diversion features of the Surplus Commodity Program, much fruit was left under the trees. This combination of circumstances supplied conditions very favorable for apple maggot development and explains in great measure why this pest is proving so troublesome in many of the better-cared-for orchards of the State.

Emergence of apple maggot flies in cages at Waltham was the smallest that has been recorded for several years. In these cages the time of emergence was 4 or 5 days earlier than in 1939. The record is as follows:

Percent Emerged	In Sun—Light Soil	
	Cultivated	Sod
First fly .....	June 25	June 30
25% .....	July 3	July 6
50% .....	July 9	July 9
75% .....	July 15	July 15
100% .....	July 25	July 26
Total .....	126	121
% emerged .....	25.4	24.2

**Insecticides for the Control of European Corn Borer.** (A. I. Bourne and W. D. Whitcomb.) The cold, wet weather which characterized most of the spring seriously interrupted the seasonal program of many growers, delayed planting, and retarded growth of the crops. In many cases corn was planted later than usual and made very slow growth after germination. Early June was comparatively warm and stimulated the



development of both the corn and the European corn borer. In Amherst and vicinity moths began to appear during the first week of June and by the 14th larvae appeared, approximately a week later than in 1939. The first sprays were applied on June 17.

Field tests of different insecticides for corn borer control were made in cooperation with the same growers as in the previous years. The variety used was Golden Early Market, the same as in 1939, and the plantings were made on approximately the same date. The late season, however, delayed growth so that the plants were much smaller than usual at the time the first spray was applied, and a schedule of 5 applications at 5-day intervals was followed. The month of June closed with a 10-day period of some of the coldest weather on record for that time of year, and practically the same condition prevailed in early July. The corn made very slow growth and was not ready to harvest until August, nearly two weeks later than normal. Derris spray (4 percent rotenone content), derris dust (1 percent rotenone), dual-fixed nicotine dust, dual-fixed nicotine as a spray (nicotine content equivalent to nicotine tannate), and commercial prepared rotenone sprays were used in the tests. Apparently one by-product of an otherwise unfavorable season was a comparatively light infestation of corn borer. Yield records showed corn in the check plots to be 85 percent free from borers. Derris spray gave 97.8 percent clean ears, and derris dust 96 percent; dual-fixed nicotine as a dust gave 97.6 percent clean ears and as a spray 96+ percent. Only 77 percent of the yield in the check plots, however, was of marketable grade; while in the plots treated with derris spray 89.8 percent of the crop was marketable, with derris dust 79 percent, with dual-fixed nicotine dust 82 percent, and with dual-fixed nicotine spray 81.7 percent—a very favorable comparison with unsprayed corn even in a year of light infestation. The derris spray gave a reduction of 95.5 percent in borer population in the stalks as compared with the unsprayed checks, derris dust 92.5 percent, dual-fixed nicotine dust 87.9 percent, and dual-fixed nicotine spray 75 percent.

Studies of the relative effectiveness of different strengths of derris, in the Experiment Station plots, encountered the same difficulties mentioned above—unfavorable weather conditions and very slight infestation by the borer. The results indicated that a dosage of 2 pounds of derris (4 percent rotenone content) per 100 gallons was not sufficient for dependable control, and that a dosage of 6 pounds to 100 gallons did not give sufficient difference in control over the 4-pound strength to warrant the extra cost.

In tests of Bancross 39 sweet corn at Waltham, five applications (June 17, 22, 27, July 2, 12) of powdered derris root 3 pounds and Ultrawet 8 ounces in 100 gallons of water produced a gain of 16 to 20 percent in the number of ears free from injury by the first generation of the corn borer. The ear infestation in the unsprayed plot was 22.46 percent, while that in the sprayed plot was 2.67 percent where a 2-nozzle spray rod was used and increased to 6.01 percent where an orchard spray gun was used. At a cost of \$1.89 per plot for spray materials, the sprayed plots produced approximately 350 and 300 ears more than the unsprayed plot.

A similar experiment was made to control the second generation of the corn borer on late sweet corn, using Carmelcross seed sown on June 21. Three applications of derris spray were made, on August 16, 21, and 27, and records were taken on September 11 when the ears were harvested. The results showed no value for spraying, the percentage of non-salable ears due to borer being 13.99 unsprayed and 14.82 sprayed. The records

clearly show that more than three applications are necessary even if they are continued nearly to harvest, since most of the infestation in the sprayed corn was from recently hatched borers. The results were further confused by a heavy infestation of corn ear worm which did not appear to be affected in any way by the sprays.

**Potato Spraying Experiments.** (A. I. Bourne.) Cold, wet weather during spring and early summer, which prevented planting at the usual time, delayed the appearance of the plants and retarded growth; subnormal rainfall which persisted through August and September and an early frost on September 25-26, which killed the plants in all plots, combined to form a sequence of unfavorable weather conditions unusual even for New England.

The experimental plots were planted on May 21 but young plants did not appear until well into June. On the east half of the plot the stand was very light with many "skips" so that a considerable area had to be discarded as useless for experimental purposes. Plants in all plots were green and still making growth when killed by the frost of September 25.

During the early season the infestation of fleabeetles was comparatively light and little damage was done. The attack in late July, however, was very heavy and there was considerable damage to unprotected foliage. Leafhoppers appeared late in the season and were not very numerous. A heavy infestation of potato aphids was encountered in late July and early August. In many fields in the Valley the abundance of aphids led to the greatest build-up of several species of Coccinellid beetles which has been observed for many years. In the experimental plots incipient outbreaks were checked by the use of nicotine in the sprays applied July 31 and August 7. In the test plots, 12 applications were made between June 20, when the plants were 3 to 4 inches high, and September 4 when the flea beetles and leafhoppers disappeared. Vines were killed by frost on the night of September 25-26, and the potatoes were dug October 1 to 3.

Weekly counts of flea beetle injury showed practically no difference in degree of protection from 5-2½-50 and the standard 5-5-50 bordeaux mixture. The addition of calcium arsenate in both mixtures, however, materially reduced the amount of damage, especially in the plots receiving low-calcium bordeaux. The growing season was three to four weeks shorter than normal because of the late appearance of the plants in the spring and the early frost in September. This was reflected in the yields. Records of comparative yield in the different plots were of little significance since plants in all plots were prematurely killed by the frost.

Tests of commercial materials included applications of a commercial basic copper arsenate-wettable sulfur, a basic copper-wettable sulfur combination, and a yellow copper oxide-Cherokee clay combination at dosages of 1½ and 1 pound of the copper oxide per 100 gallons of spray. Against flea beetle feeding both the basic copper-sulfur combinations gave excellent protection, fully as good as that given by the standard bordeaux with calcium arsenate added. The yellow copper oxide sprays furnished protection equivalent to standard bordeaux without arsenical.

Records at harvest showed that plots treated with the commercial sprays yielded approximately 350 bushels per acre, which was only slightly less than the yield in the standard bordeaux plots. It is probable that greater differences would have existed if early frost had not intervened, since the plants in these plots were beginning to change color and die down while throughout the bordeaux plots the plants were still green.

**Introduction of Parasites of Oriental Fruit Moth in Peach Orchards.** (A. I. Bourne.) This service, requested and financed by peach growers of the State, was continued in 1940, and more than 30,000 *Macrocentrus ancyliivorus* were liberated in the orchards. Through the cooperation of the Department of Entomology of the Connecticut Experiment Station, Mr. A. DeCaprio was again secured to take immediate charge of this work from June 1 to July 15. More than 80 colonies of *Macrocentrus* parasites were released in the orchards of 63 growers in 9 counties of the State. Several of the county agents assisted in the release of the parasites and enabled the work of liberation in the orchards to be done with greater dispatch than would otherwise have been possible. As a result of the efficient work of Mr. DeCaprio in the collection of breeding material in New Jersey and improved technique in the laboratory, the percentage of emergence was so very high that it was possible to supply parasites for all advance orders and furnish to the county agents enough colonies to duplicate orders. The Laboratory also supplied colonies to Dr. Christopher, extension horticulturist of Rhode Island State College, for the peach growers of that state on the same terms extended Massachusetts growers. Many growers availed themselves of the offer made this year to furnish colonies in two containers. This allowed, in separate blocks or different parts of the same orchard, distribution of parasites with the proper proportion of sexes for satisfactory colonization.

During the period when the parasites were liberated weather conditions were favorable for their activity, and little or no mortality was noted.

**Naphthalene and Similar Compounds as Greenhouse Fumigants.** (W. D. Whitcomb and Wm. Garland, Waltham.) A complete series of thirty experimental fumigations of potted carnations was made, using a mixture of chlornaphthalene oil 3 parts and crystal naphthalene 1 part, at the rate of  $\frac{1}{2}$  ounce per 1,000 cubic feet for 6 hours.

One treatment gave complete control of the common red spider (*Tetranychus telarius* L.) at a controlled constant temperature of 80° F. and constant relative humidities of 80 or 90 percent. At temperatures of 60° and 70° F., and relative humidities of 80 and 90 percent, the mortality of red spiders ranged from 80 to 90 percent; while at 50 percent relative humidity the mortality varied from 50 to 83 percent.

After two successive fumigations, complete mortality resulted at 50 percent relative humidity with a constant temperature of 80° F.; at 60 percent humidity with constant temperatures of both 70° F. and 80° F.; and at 70 percent humidity or higher at all three temperatures.

These results were obtained only when the controlled temperature and relative humidity were maintained throughout the entire period of exposure.

**Control of the Common Red Spider on Greenhouse Plants.** (W. D. Whitcomb, Wm. Garland, and W. E. Tomlinson, Jr., Waltham.) Life-history studies under controlled conditions indicated that female red spiders (*Tetranychus telarius* L.) on carnations developed from newly hatched larvae to adults in 16.91 days at 60° F., 10.22 days at 70° F., and 6.07 days at 80° F. The same development took approximately one day less on sweet pea and one-half day less on snapdragon than on carnation. This difference was consistent at constant temperatures of 60°, 70°, and 80° F. As observed in previous studies, the developmental period at 60° F. was about three times longer than at 80° F.

In spraying experiments on roses in greenhouse benches using 8 different commercial rotenone preparations, the addition of a neutral copper fungicide decreased the efficiency of the insecticide against the red spider about 5 percent in those materials consisting primarily of rotenone and emulsifier. However, in those preparations in which rotenone was combined with other insecticidal ingredients such as thiocyanate or light mineral oil, the addition of a neutral copper fungicide had no significant effect on the red spider mortality.

In these experiments satisfactory control was obtained after four applications at weekly intervals only with those materials which contained some insecticidal ingredient in addition to rotenone and emulsifier. According to counts made 3 to 5 days after each of four applications at weekly intervals, only those sprays which caused a mortality of 50 percent or greater prevented the spider population from increasing during the spraying period; and in some cases where the population was held in check during the spraying period, it increased so rapidly after spraying was discontinued that within one week the infestation was greater than after the first application.

Many of these commercial sprays were more effective at concentrations two to three times greater than recommended by the manufacturers.

Preliminary experiments on potted rose plants gave promising results from a mixture of tartar emetic, brown sugar and wetting agent, but it was ineffective when the brown sugar was omitted. Indications of plant injury from this material were observed.

A dinitro dust was very toxic to red spider on both rose and carnation but caused some injury to rose foliage.

**Biology and Control of the Apple Leaf Curling Midge.** (W. D. Whitcomb, Waltham.) The apple leaf curling midge, (*Dasynura mali* Kieff.) was generally more abundant than in 1939 and the known infested area was increased to the west and southwest by the discovery of this insect at Ashby and Westboro, Massachusetts.

In the insectary only one midge fly emerged from 325 maggots which were collected in June, July, and August 1939 and overwintered in sand, but flies emerged in 1940 from 8 to 36 percent of the maggots which were collected in September 1939 and held over winter in the same way. The transformation to flies was 42.42 percent from the maggots collected in June; 27.6 percent from those collected in July; and 13.33 percent from those collected in August.

The orchard infestation at Westford, Massachusetts, as indicated by the percentage of terminal buds on which eggs were laid, began May 24 and reached three distinct peaks on June 4-7, July 16-19, and August 23, when eggs were found on 99 to 100 percent of the buds. After June 25 practically all new growth is on watersprouts, and on trees where watersprouts are limited the actual number of eggs is relatively small even though the percentage of buds infested is high. After August 25 only one or two growing tips suitable for oviposition by the midge flies could be found on a tree.

The emergence of maggots from rolled leaves was concentrated in two distinct peaks, that of the first generation larvae occurring on June 25 and that of the second generation larvae reaching a maximum on August 2 but being spread out over the period July 20 to August 9. Emergence in large numbers occurred only when accompanied by sufficient precipitation to thoroughly soak the leaves.



The average number of eggs per female midge fly as determined by dissection of 12 gravid adults of the second generation was  $155.5 \pm 6.66$ , varying from 102 to 216.

Infested apple buds during the oviposition period of the first generation flies averaged  $318.1 \pm 13.47$  eggs per bud, varying from 198 to 404.

Applications of naphthalene flakes broadcasted under the trees reduced the number of flies of the overwintering generation emerging in cages by 83.4 percent where 1 pound of naphthalene per 100 square feet was applied, and by 80.9 percent where 2 pounds was used. The emergence of the first generation flies under similar conditions was reduced 75.42 percent by 1 pound of naphthalene and 93.31 percent by 2 pounds. The emergence from the untreated ground was 3.56 overwintering generation flies per square foot and 22.87 first generation flies per square foot. Emergence of flies from duff (dried leaves, hay, etc.) collected in the experimental orchard and caged in the insectary was none from duff treated with 2 pounds naphthalene per 100 square feet compared to 28.5 flies of overwintering generation per pound of untreated duff, and 3.69 flies of the first generation per pound of naphthalene-treated duff compared to 78.46 flies per pound of untreated duff.

Preliminary laboratory experiments with dormant sprays on apple bark containing an unknown number of overwintered midge cocoons showed no survival where dinitro sprays were applied, and a small survival where oil emulsion was applied or no treatment was given. These results were inconclusive but offer some encouragement for control by dormant sprays applied to the bark.

**Control of Plum Curculio in Apples.** (W. D. Whitcomb, Waltham.) The critical period of curculio activity in 1940 began on June 1, five days after the normal petal fall stage, and continued to June 7. During this period, sprays consisting of lead arsenate 4 pounds, wettable sulfur 4 pounds, and fish oil 1 pint, were applied to certain trees when the apples of each variety were approximately 4/16, 5/16 and 6/16 of an inch in diameter, as determined by measurements with calipers. The examination of 128,888 apples resulted as follows:

Variety	Size of Fruit (Inches)	Date Spray Applied	Apples Stung (Percent)
Gravenstein	4/16	June 1	20.18
	5/16	June 3	9.95
	6/16	June 5	33.28
McIntosh	4/16	June 4	7.08
	5/16	June 5	3.08
	6/16	June 7	8.35
Baldwin	4/16	June 1	4.80
	5/16	June 3	3.22
	6/16	June 5	6.14
Wealthy	4/16	June 3	5.55
	5/16	June 4	11.19
	6/16	June 5	15.13

The most effective sprays on Gravenstein, McIntosh and Baldwin were applied when the apples were approximately 5/16 of an inch in diameter and on Wealthy at the 4/16 inch size. It is also evident that the most effective spray was applied June 3 at which time the maximum temperature and greatest curculio activity of the period occurred, and that the high temperature stimulated both curculio activity and growth of apples. One timely spray during the critical period is satisfactory on McIntosh, Baldwin, and Wealthy but not on Gravenstein. On Gravenstein and Baldwin the percentage of curculio-stung apples was from 50 to 100 percent greater on the dropped apples than on the harvested apples, but on McIntosh and Wealthy the injury was 5 to 10 percent greater on the harvested fruit.

A growth of 1/16 of an inch in diameter of an apple represents an increase in surface area of 156 percent, and since this growth may occur in 24 hours, timeliness in the application of a spray is important.

**Biology and Control of the Grape Plume Moth and Grape Cane Girdler.** (W. D. Whitcomb and W. E. Tomlinson, Jr., Waltham.)

*Grape Plume Moth.* Life history studies of the grape plume moth showed that larvae hatched from 57.89 percent of the eggs which were overwintered on potted grape vines, and that all hatching occurred in the three-day period, May 14-16. The feeding period of larvae averaged 39.2 days and the pupation period 16.37 days, making a developmental period from hatching to adult of approximately eight weeks. Because of cool weather, this period was about two weeks longer than in 1939.

On heavily infested vines the number of overwintering eggs averaged 3.36 per foot of cane, or 3.18 eggs per node. Since each node ordinarily produces a shoot, this infestation is equivalent to about 3 insects for each growing shoot.

Laboratory experiments with commercial dormant spray materials gave complete mortality of eggs with lubricating oil emulsions containing 3 or 4 percent actual oil, and 90 percent mortality or higher with 1 or 2 percent actual oil in the diluted spray. Lime sulfur 1-8 gave 80 percent mortality of the eggs. Sodium dinitro cresylate was effective when diluted to 1 and 1¼ percent, but at dilutions of ½ and ¾ percent only 48 percent mortality resulted. On unsprayed canes, 63 percent of the larvae hatched.

Field experiments in home vineyards showed 80.4 percent protection where lubricating oil emulsion diluted to contain 3 percent actual oil was used, and 72.86 percent where ¾ percent sodium dinitro cresylate was used. On unsprayed vines 84.12 percent of the tips were infested. In another experiment where 58 percent of the tips on unsprayed vines were infested, treatment with ½ percent sodium dinitro cresylate gave 92 percent protection, and lime sulfur 1-8 gave 11 percent protection.

Spraying on May 1 when the buds were breaking and about one week before the larvae hatched, using lead arsenate and fish oil and lead arsenate combined with Bordeaux mixture, failed to give protection.

*Grape Cane Girdler.* Emergence of the grape cane girdler beetles from hibernation and their appearance in the vines occurred when the new canes were about 6 inches long. They also appeared to be stimulated by high temperatures to the same degree as the plum curculio. Mating occurs soon after the beetles leave hibernation and the first girdled canes were observed June 2.

On potted grape vines in the insectary, mated beetles averaged 3.13 oviposition punctures per female, but observations indicate a greater oviposition activity in the field. The average life of 27 individuals reared in the insectary from oviposition to adult was 54.55 days.

When burrowing in the cane, most of the larvae work toward the base of the cane rather than toward the tip, and when control by hand picking is practiced, the infested cane should be removed well below the lowest girdle.

Spraying experiments with cryolite and fish oil gave moderate protection, but during the most rapid growth of the grape canes applications at weekly intervals permitted considerable girdling between treatments.

**Parasites of the European Earwig.** (W. D. Whitcomb, Waltham.) In order to follow up the liberation of parasites in the Fall River-Taunton area in 1939, twenty earwig traps or hiding blocks were placed in June 1940 in the localities where parasites had been released. These were examined in July, August, September, and October, but no specimens of the earwig parasite, *Bigonichaeta setipennis*, were recovered.

The earwig population throughout the infested area was less than in 1939, especially in Fall River where the number recovered in traps was 78 percent less. In the Somerset-Taunton area, the number of earwigs captured was 26 percent less than in 1939.

**Insects Concerned in the Dispersal of Dutch Elm Disease.** (W. B. Becker.) Mr. W. E. Tomlinson, Jr., at the Waltham Field Station again cooperated by continuing experiments with the native elm bark beetle and the smaller European elm bark beetle. The following data were taken.

*The Native Elm Bark Beetle, Hylurgopinus rufipes (Eich.).* In the logs (mentioned in last year's report, page 66) from hurricane-felled trees in which eggs were laid in early June 1939 and from which adults began to emerge on July 29, 1939, emergence was observed to continue until November 3, 1939. No emergence was observed from these logs during 1940.

*The Smaller European Elm Bark Beetle, Scolytus multistriatus Marsham.* In the logs (mentioned in last year's report, page 66) from hurricane-felled trees in which eggs of this species were laid in early June 1939 and from which adults began to emerge on July 20, 1939, the emergence was observed to continue until September 10, 1939. Emergence was again observed from these same logs on June 5, 1940, and continued until July 22, 1940, (173 beetles emerged during 1939 whereas 883 emerged during 1940 from the same caged material).

**Scouting for Elm Bark Beetles.** (W. B. Becker.) In conjunction with Dr. D. O. Wolfenbarger of the Dutch elm disease laboratory at Morristown, New Jersey, scouting for *Scolytus multistriatus* was carried on in various parts of Massachusetts, especially in places where spread was most suspected. Adult beetles were found in Western Massachusetts at Richmond Furnace, Stockbridge, West Stockbridge, and Monterey, and in eastern Massachusetts at Marlborough and East Pepperell—all locations where they had not been previously found.

## DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

**Breeding Snapdragons for Varietal Improvement and Disease Resistance.** (Harold E. White, Waltham.) Back-crossing and selection work is being continued with the Field Station rust-resistant strains. Greenhouse varieties of snapdragon, Lucky Strike, Afterglow, New Cincinnati, Laura, Cheviot Maid, Rose Orange, Bronze Queen, Cornwallis, and Rose Queen, were observed to be very susceptible to rust disease under field conditions. When such varieties were intercrossed, the progeny of the  $F_1$  and  $F_2$  generations continued to show a high degree of susceptibility to rust. However, the  $F_3$  generation selections, particularly from a cross between Lucky Strike and Afterglow, showed definite resistance to rust disease. This is an unusual situation in that the existence of natural resistance in susceptible commercial varieties of snapdragons has not been definitely proved. The explanation offered for this type of resistance to rust is that these varieties must carry modifying genetic factors which, under conditions of intercrossing and inbreeding, permit a more complete expression of the resistance factor. The nature of this type of resistance and the extent to which it can be developed by breeding must be determined by further work.

Wilt disease (*Verticillium*) continues to be destructive to snapdragons in the field, though of rare occurrence under greenhouse conditions.

**Effect of Plant Nutrients, Soil Reaction, and Light on Gardenias.** (Harold E. White, Waltham.) Previous experiments were concerned with the effects of different nitrogenous fertilizer materials on flower production, bud drop, and iron chlorosis. This type of work has been continued with three phosphate fertilizer materials to determine whether readily available phosphoric acid, as compared to less available forms, had any specific effect on growth of gardenia plants. Additional phosphoric acid in the form of bone meal, precipitated bone, and superphosphate (16 percent), applied to soils in sufficient quantities to supply 320 pounds  $P_2O_5$  per acre, affected flower production appreciably.

Yields on untreated plots were 20.16 flowers per plant; on plots receiving precipitated bone, 22.39; bone meal, 20.91; and superphosphate, 17.19 flowers per plant.

Bud drop was perceptibly greater on plants given organic forms of phosphoric acid. Untreated plants showed 33.88 percent bud drop; those receiving applications of precipitated bone showed 34.70 percent; bone meal, 39.40 percent; and superphosphate, 29.30 percent bud drop.

Symptoms of chlorosis due to a lack of iron were definitely more severe on plants that received superphosphate than on those given either bone meal or precipitated bone.

**Cultural Requirements of Freesias.** (Harold E. White, Waltham.) Freesia corms dried or precured for 28 days and planted September 14, 1939, required 155 days to reach the flowering stage, as compared to 165 days for untreated corms planted on August 17. Corms dried for 9 weeks and planted October 19 flowered in 130 days. The number of days necessary for Freesias to reach the flowering stage decreased in proportion to the lateness of planting, but the actual date of bloom was not affected by precuring treatments. Corms untreated and planted August 17 bloomed



on an average of two weeks sooner than precured corms. The plant growth and productivity of the corms were not affected by precuring treatments prior to forcing.

Freesias subjected to constant temperatures of 50°-52° F. during the rooting period after precuring were not affected favorably or unfavorably by such a treatment. Corms precured at temperatures of 45°-46° F. in a refrigerator for 1 to 4 weeks did not flower any sooner than those given a warm storage treatment.

Treatments of precuring for 1 to 11 weeks prior to forcing resulted in a loss in dry weight of the corm to the extent of 1 to 24 percent, but there was no correlation between losses in weight and forcing characteristics of the corms.

The data presented were on the variety Purity. Tests in progress with the variety Daffodil indicate that possible varietal differences may exist.

These responses of Freesias to precuring treatments were obtained with forcing temperatures of 52°-55° F.

**Soilless Culture of Florists' Crops.** (Harold E. White, Waltham.) Marigolds, calendulas, poppies, snapdragons, stevia, sweet peas, carnations, roses, and gardenias were grown in cinders in comparison with soil. The annual type of flowers responded quite satisfactorily to culture under soilless conditions.

Rose plants of the variety Chieftain produced an average of 16.43 flowers per plant compared to 21.37 blooms in cinders. There was 77.18 percent of flowers with 12-15 inch stems from soil-grown plants as compared to 82.45 percent from plants grown in cinders. The gain in production of 12-15 inch grades from plants in cinders was 5.27 percent.

With the variety Talisman, flower production was greater from plants in soil, 25.68 blooms per plant in comparison with 23.75 blooms per plant in cinders. However, on a grading basis Talisman plants in soil produced 79.32 percent of flowers with 12-15 inch stems as compared to 82.90 percent in cinders. The gain in production of 12-15 inch grades was in favor of cinder-grown plants to the extent of 3.58 percent.

Sweet peas sown in August in soil in a raised bench produced twice as many flowers as plants grown in cinders. Sweet pea blooms from plants in cinders were superior to those from plants grown in soil. There was a much more pronounced stimulation of vegetative growth of the sweet pea plants grown in cinders than of soil-grown plants.

Carnations responded very poorly to culture in cinders and production was inferior to that of plants in soil. However, the plants available for use in the cinders were of poor quality which may be an explanation for the poor results obtained. At least, the results would indicate that weak, inferior plants cannot be expected to respond any more satisfactorily under soilless culture methods than they would in soil.

Carnation plants growing in cinders or gravel were successfully fumigated with naphthalene compounds for the control of red spider. Fumigations were made without flooding the benches with water.

One observation in a commercial range on the use of naphthalene fumigants on carnations in gravel indicates that injury can occur. In this particular case burning of the plants occurred under soil conditions as well as on plants in gravel; apparently fumigation conditions as related to temperature, humidity, or rate of vaporization were not properly controlled. Burning of the foliage was more severe on plants grown in gravel and a

greater percentage of bud injury occurred. However, the plants in gravel made a more rapid recovery from the injury than did plants grown in soil; this was evidenced by vegetative growth response on the plants.

Gardenias did not respond favorably to culture in cinders. The chief difficulty experienced was getting the plants to take up sufficient iron to maintain normal growth. Plants which became quite chlorotic from a deficiency of iron never satisfactorily recovered even after considerable manipulation of the nutrient solutions.

**Banana Stalk Fiber as a Source of Organic Matter for Soil Improvement.** (Harold E. White, Waltham.) Crushed banana fiber is a waste or by-product which has been marketed by the Meloripe Fruit Company of Boston for several years. The value of this material for use as a mulch on plantings of shrubbery and market garden crops has been demonstrated previously at the Waltham Field Station.

In recent tests shredded banana fiber composted with soil for 10 to 12 months has been found satisfactory for use in the greenhouse culture of carnations and snapdragons. Banana fiber, as determined by analyses, is relatively high in carbonates of magnesium and potassium and, therefore, is alkaline in reaction. Such a material would be most satisfactory with a soil that is too acid, but if used on soil with a low lime requirement, the liming value of the banana fiber should be taken into consideration.

Cultural comparisons were made between ordinary stable manure, spent mushroom manure, and the banana fiber. The banana fiber and mushroom manure were found to have a toxic effect on gardenias, causing iron chlorosis. This was probably due to the high lime content of the materials. Therefore, they should not be used on crops which have a low lime requirement, or they must be leached well with water to remove most of the soluble carbonates.

**Liming Carnation Soils.** (Harold E. White, Waltham.) Carnation plants of the variety New Deal Ward, grown in a soil that received no lime, produced 23.40 flowers per square foot. When lime was applied to the same type of soil at the rate of 1 ton per acre, the carnation plants produced 21.10 flowers per square foot; 1½ tons yielded 22.40 flowers; 2 tons, 20.10 flowers; and 3 tons, 21.30 flowers per square foot.

The percentages of flowers with split calyces produced by plants in the various treatments were: unlimed, 21.50 percent; 1 ton of lime, 23.20 percent; 1½ tons of lime, 24.70 percent; 2 tons of lime, 22 percent; and 3 tons of lime per acre, 25.60 percent. The average acidity test of the soil prior to liming was pH 5.6. At the termination of the experiment, soil tests on the untreated and treated plots were: No lime, pH 4.6; 1 ton of lime per acre, pH 5.3; 1½ tons, pH 5.7; 2 tons, pH 5.9; 3 tons, pH 6.4.

Plant losses from soil-borne disease organisms such as root, stem and branch rot were very low. There appeared to be no correlation between limed and unlimed soils as to the prevalence of diseased plants.

**Packet Seed Studies.** (Clark L. Thayer.) For a fifth season the Department of Floriculture has cooperated with the Seed Laboratory in a test to determine the quality of flower seeds sold in retail seed stores, garages, hardware stores, groceries, schools, and other retail outlets. The seeds, which were collected by a representative of the State Commissioner of Agriculture, were tested for germination and performance under field conditions.

The test included 194 lots, representing 46 genera, packeted by 32 wholesale establishments, and obtained from 53 retail outlets. Records on germination showed 146 lots, good; 30 lots, fair; 16 lots, poor; 2 lots, none. Records on performance showed 155 lots, satisfactory; 6 lots, fair; 33 lots, not satisfactory. Detailed results are reported in Control Series Bulletin 107.

## DEPARTMENT OF HOME ECONOMICS NUTRITION

Helen S. Mitchell in Charge

**Vitamin Requirements of Older People.** (H. S. Mitchell and A. W. Wertz.) Scientific knowledge regarding the chemical nature and physiologic function of vitamins has progressed by leaps and bounds in recent years, but knowledge regarding the human requirements for the different vitamins has not kept pace with other phases of vitamin research. The vitamin requirements of young adults, college students, and children have been studied to a limited extent and more with regard to vitamins A and C than any others. Little, if anything, is known regarding the vitamin requirements of older people or the vitamins most significant in the maintenance of optimum health with advancing years. Thiamin seems to be the one most apt to be deficient.

Reports from various parts of the country, mostly in the medical journals, indicate that thiamin (vitamin B<sub>1</sub>) administered in liberal dosage has brought about considerable improvement and in some cases complete relief from various chronic complaints and discomforts commonly associated with and accepted as inevitable accompaniments of old age. A question as to why increased need for thiamin should become evident in middle age has never been answered. Minor changes in food habits may decrease the amount of vitamin consumed; metabolic changes may increase the need; or chronic infection may destroy or use extra vitamin, thus depriving the body of its normal supply. Thus it is proposed to ask the cooperation of a limited number of people living in Amherst to help us in the study of the thiamin requirements of reasonably normal people in the seventh and eighth decades of life. Such an experiment is possible only where intelligent and scientifically minded people are willing to give their interest and support to the project.

A few years ago it would have been impossible to propose a study of this kind because so little was known concerning the function of thiamin in the body. Today we know that the body cannot store thiamin to any extent and that the excess beyond what we need is excreted in the urine unchanged. A small excess of the vitamin can do no harm. If the body has received less than its normal requirement for some time, it will temporarily store thiamin in the tissues, when given a chance, until its quota is filled. If there has been no deficiency, the excess vitamin ingested will be excreted promptly. Thus the need of the body can be studied by measuring the excess excreted in the urine after the need of the body has been satisfied.

Another reason why a study of this kind can be undertaken today better than earlier is the improvement in methods for estimating thiamin quantitatively. Until recently we were dependent upon animal feeding tests which were tedious and expensive. Today there are two or three chemical

methods available and also a yeast fermentation method. Yeast cells require thiamin in order to grow and cause sugar to ferment. The latter method is suitable for the determination of thiamin in urine and is the one we are using.

The subjects who participate in this study will be contributing both to scientific knowledge and to their own well-being, we hope. Each subject will be expected to submit to a complete physical examination by a cooperating physician. Subjects will not be expected to alter their usual food habits or disrupt their daily routine in any way. They will be asked to keep a record and furnish us with a list of foods eaten for a week or more preceding and during certain tests. Any medicines, laxatives, vitamin supplements, etc., will need to be recorded. Subjects will be asked to collect accurate 24-hour urine specimens. The plan of the experiment will be to study first the usual amount of thiamin excreted by each subject on his habitual diet without vitamin supplement of any kind. After this preliminary study, carefully graded doses of thiamin will be prescribed.

This project was started in the fall of 1940 and is being sponsored partially by Standard Brands Incorporated.

**Cause and Control of Nutritional Cataract.** (H. S. Mitchell, G. M. Cook and A. W. Wertz.) The experimental production of cataract in rats by feeding rations containing galactose has become a means of studying the effect of other dietary factors upon the lens. The susceptibility of this delicate tissue to injury from foreign substances as galactose in the blood stream is materially reduced by a liberal amount of protein in the ration. Whether protein or some nitrogenous substance might be protective against lenticular injury due to other causes than galactose is not known. The nature of the protein or of the protein constituents which might exert this protective action have been the subject of further study, and reports have been published as follows:

1. *The Anti-Cataractogenic Action of Certain Nitrogenous Factors.* (H. S. Mitchell, G. M. Cook, and M. D. Henderson. Arch. Opth. **24**, 990-98, 1940.) Data presented in this paper confirm earlier reports that inadequate protein (5 percent) aggravates and that high protein (45 percent) inhibits the development of cataract in rats fed galactose. Attention was then turned to the investigation of certain nitrogenous factors. An enzymic hydrolysate of casein gave the same degree of protection as its nitrogen equivalent in commercial casein. Cystine (2 percent) and methionine (2 percent) gave only slight or irregular protection. Moreover, when the sulphydryl amino acids were made less available by the addition of 100 mg. of iodoacetic acid or 250 mg. naphthalene to 100 g. of ration, growth was retarded but cataractous changes were not hastened. Urea at 1, 5, and 10 percent levels gave less protection than an equivalent of N fed as protein. Choline was studied by adding 1, 2, 4, and 8 percent to a 5 percent casein ration. Growth was progressively poorer the higher the level of choline fed and there was no protection against cataract.

2. *The Effect of Dry Heat Upon the Anti-Cataractogenic Quality of Certain Proteins.* (M. D. Henderson and H. S. Mitchell. J. Nutri. **21**, Feb. 1941.) The knowledge that protein exerts protective action against galactose injury in rats, raises the question as to whether the type of treatment which is known to decrease the growth value of a protein will also affect its cataract-inhibiting quality. The four proteins—casein, egg albumin, wheat gluten, and beef fibrin—were fed as purchased and after being



exposed to dry heat for 96 hours at 125° C. These proteins were then incorporated into a 25 percent galactose ration in amounts to furnish 15 percent of protein. The ration was entirely adequate in other factors.

The growth value of these proteins was damaged by heat in the decreasing order: gluten, casein, fibrin, egg albumin. The anti-cataractogenic property was reduced by heating in the decreasing order: casein, egg albumin, gluten, fibrin. Thus these two properties of protein were not damaged to the same degree by exposure to dry heat. It follows that, if the protective factor is an amino acid or group of amino acids, they are not necessarily the same as those essential for growth.

The blood-sugar values tended to be higher in the rats fed heated casein than in the plain casein groups but were not significantly different for the other proteins before and after heating. It would appear that the degree of galactemia cannot alone account for the difference in the degree of lenticular injury observed. Thus it seems that the protein factor may be protective in the presence of the high blood galactose.

3. *The Effect of the Hydrolytic Products of Casein and Deaminized Casein on the Cataractogenic Action of Galactose.* (E. L. Moore, M. D. Henderson and H. S. Mitchell. *J. Nutri.* **21**, Feb. 1941.) (Department of Chemistry cooperating.) Preliminary work showed that deaminized casein was more protective against galactose cataract in rats than ordinary commercial casein from which it was prepared. Other work has indicated that the type of treatment which alters the growth value of a protein may or may not affect its anti-cataractogenic quality. Hydrolytic products of casein and deaminized casein were prepared by both acid and enzymic hydrolysis and were fractionated by Dakin's method. The whole proteins or the hydrolysates were fed on the basis of the nitrogen equivalent of 10 percent of protein fed as casein. The fractions were fed in amounts proportional to the respective yield of each.

The enzymic hydrolysate of deaminized casein was somewhat more protective than the deaminized casein from which it was prepared. Of the fractions, the diamino-dicarboxylic acid fraction of the enzymic hydrolysate afforded as much protection as the whole hydrolysate, while the monoamino and proline and peptide fractions showed no protection whatever. Blood-sugar determinations indicated that the protective action was exerted in the presence of the high blood sugar and not by a lowering of the blood sugar level.

4. *The Influence of Certain Diamino and Dicarboxylic Amino Acids upon the Cataractogenic Action of Galactose.* (H. S. Mitchell and G. M. Cook.) Following the lead suggested by the work just reported, some individual amino acids are being investigated. Glutamic acid, histidine, and arginine are all present in the protein hydrolysate fraction found to be most protective in the previous work. The amino acids are being fed incorporated in a low-protein galactose ration in order to observe any possible protective action. Results are not yet available.

5. *Time Factors in the Development of Galactose Cataract.* (G. M. Cook and H. S. Mitchell.) It has been observed in this and other laboratories that young rats are more susceptible to galactose injury than older rats. An experiment designed to investigate the question of this age factor is in progress. Rats from the same litter are started on experimental rations at fortnightly intervals. The ones started later require a longer time for lenticular injuries to become evident. The data are not yet complete.

The injury due to galactose seems to persist in rats after they have been transferred to rations containing none of this sugar. The blood sugar returns to normal within a few hours after the ration change is made. The apparent lag in the galactose injury must be due to slow diffusion from eye fluids. The extent of this lag is being investigated by discontinuing the galactose ration at four-day intervals on a series of rats from the same litter.

6. *The Influence of Different Salt Mixtures on the Utilization of Lactose.* (H. S. Mitchell and A. W. Wertz.) Preliminary evidence indicates that the amount and type of mineral elements in a ration may influence the rate of breakdown and absorption of lactose. Two commonly used salt mixtures seem to have slightly different effects. Experiments in progress are designed to study the effect of the type and amount of salt mixture on the growth, blood sugar, diarrhea, and lenticular change of rats fed a 60 percent lactose ration.

## DEPARTMENT OF HORTICULTURAL MANUFACTURES

W. W. Chenoweth in Charge

**Cranberry Research.** (C. R. Fellers and A. S. Levine.) Further study has shown that dextrose can be substituted for approximately one-third of the sucrose in canned cranberry sauce with no loss in quality. This finding should result in savings of about \$45,000 on the canned cranberry sauce packed in Massachusetts alone.

Preliminary studies on cranberry seed oil show it to be a bland sweet oil containing approximately 200 U. S. P. units of vitamin A per gram as well as some antirachitic substance. Ursolic acid, a constituent of cranberry skins, was found to be entirely non-toxic to laboratory animals and men. Ursolic acid is a good emulsifying agent and may prove useful in certain food preparations.

Disintegration of cranberry waste (skins and seeds) in a hammer mill gives a finely divided mass which can be put back into the sauce to increase the yield. Since the pulper waste constitutes from 5 to 9 percent of the weight of the cranberries, recovery of this pectinous waste and its use in canned cranberry sauce should prove of marked economic interest. The percentage analysis of the disintegrated pulp showed: protein 11, fat and wax 20.3, nitrogen free extract 38.5, fiber 26.6, ash 2.5, and pectin (alcohol precipitate) 21.7.

**Apple Products Including Apple Juice.** (C. R. Fellers, A. S. Levine, W. A. MacLinn.) Except for the baking trade, canned apples have not been widely used by the consuming public. In a previous study (*Canning Age*, 20, (No. 2): 68-70, 82 and (No.4): 179-181, 1939), methods are described for packing canned baked or glazed apples. As a result of this study, several canners are now successfully packing this product.

Apple rings or sliced apples in syrup were extensively studied during the past year. In order to obtain good clearing and syrup penetration into the tissues, it was necessary to vacuumize the carefully cooked slices. The sugar hardens the fruit and a very acceptable apple dessert is thus obtained. A 40 percent sugar syrup consisting of 2 parts of sucrose to 1 of dextrose gave excellent results. The canned products retain their color

and flavor very well during storage. The data are published in *Fruit Products Journal* 20 (No. 1): 5-6, 25, 1940.

Bulletin 336, "Apple Cider and Cider Products" was reprinted, the supply having been entirely exhausted. Considerable time has been given to persons interested in making clarified apple juice, canned apple juice, and fermented cider of the sparkling type. Clear, sparkling bottled ciders containing both 3 and 7 percent alcohol have been prepared in the laboratory. Due to difficulty of control and clarification, it is not recommended that apple growers or small cider pressers attempt to produce cider containing 3 percent alcohol. A study was made of various clarification methods, including the use of pectin-dissolving enzymes and gelatin-tannin solutions. Deaeration of fresh apple juice was not found helpful in retaining the ascorbic acid or in improving flavor. There is some evidence that deaeration decreases can corrosion in canned apple juice.

**Fruit Jellies.** (C. R. Fellers, A. S. Levine, and F. B. Voit.) Efforts were concentrated on perfecting cider jellies and apple marmalades. Cider jelly was much used in colonial times and was prepared simply by boiling apple juice until it solidified into a tough rubbery mass at concentrations varying from 7 or 8 to 1. Jellies were prepared from cider in several ways such as by concentrating the clarified apple juice to one-half of its volume, adding sufficient sugar to make 50 percent soluble solids, and concentrating further to 68 or 70 percent solids, at which point a jelly is formed. For ciders from some apple varieties, the addition of pectin is necessary. As a suggested home recipe, boil 1 quart of fresh cider to a volume of 1 pint. Add 2 cups of sugar. Boil to a strong jelly test (221° F.). Depending upon the variety and condition of the apples, a little heat-extracted juice from either the fruit or pomace may be added as a source of pectin.

A good jelly of characteristic flavor can also be made from hard cider with the aid of added pectin and sugar. Very little alcohol remains in the finished product.

The base for cider marmalade was apple juice concentrated to 30 percent solids. Sugar was added to bring up the solids to 50 percent, and the temperature raised to 220° F. Thin slices of apple suspended in the jelly before it was poured into glasses cleared well and gave an attractive and tasty marmalade.

**Nutritional Studies on Dog Foods.** (John Bernotavicz.) A study has been in progress on the use of dried buttermilk powder as the major source of animal protein in a dry dog food. Exactly 50 percent of the animal protein fed was derived from this source. The chemical composition of buttermilk used was 33.72 percent protein, 6.75 percent fat, and 10.20 percent ash. Also present were 85 I. U. of vitamin B<sub>1</sub> per 100 grams and 1950 mgms. of riboflavin per 100 grams of buttermilk powder. The growth-promoting quality of the protein was excellent. The weekly gain in weight of the control dogs fed on a high-grade ration was 0.60 pounds as compared to 0.95 pounds for the animals on experiment. Both groups were fed 40 grams of food per kilo of body weight. Despite the high lactic-acid content of the powder, dogs raised from puppies showed no tendency towards diarrhea. The experimental animals showed a more glossy coat and more subcutaneous fat than the controls.

Work under way, at the present time, on dry dog biscuits shows that 10 percent of the total intake as casein prevents running fits in dogs. On

the other hand, 5 percent of the total intake as canned dog food fails to prevent this condition.

**Citrus By-products.** (A. Sedky, C. R. Fellers, and W. H. Fitzpatrick.) A new method of making marmalade has been developed in which the orange peel is cooked separately. Retention of as much as 80 percent of the ascorbic acid as well as better flavor and color is made possible by use of this procedure. The time required for the preparation of marmalade may be greatly reduced if concentrated orange juice is used.

Experimental packs of both canned grapefruit sections and juice show that dextrose may successfully replace sucrose as a sweetening agent. In bottled grapefruit juice, the loss of ascorbic acid was proportional to the amount of oxygen present in the juice and container headspace. Thus, deaeration of fruit juices and vacuumization of the filled container are desirable in order to conserve the maximum amount of ascorbic acid in the bottled juice. Flavor is likewise improved.

**Red Squill Research.** (Cooperative with U. S. Fish and Wildlife Service.) (A. S. Levine and J. A. Lubitz.) Three papers are in press bringing up to date the publication of most of the red squill investigations. These include reports on the toxicity of squill to various animals, the factors affecting toxicity of red squill baits, and the relative values of several volatile oils and imitation food essences as rat lures.

Investigation has been completed to determine the optimum percentage of red squill powder to be used in baits. The more toxic the squill, the smaller the quantity required per bait. Thus, the more toxic squills are the most efficient and therefore more economical although the initial cost may be high at face value.

In a comparison of type of baits, the rats ate corn meal-squill baits in marked preference to poisoned baits made with meat or fish.

**Preservative Values of Organic Acids.** (A. S. Levine.) Investigations are being conducted to improve the preservation of soda fountain syrups and fruit juices. The present practice of adding citric acid and sodium benzoate is not entirely satisfactory. The substitution of acetic acid (vinegar) for part of the citric acid may lead to better keeping qualities without the need of sodium benzoate. Other organic acids are being studied and compared for their effect on the growth of yeast and molds.

The availability of sodium glycollate medium for the cultivation of anaerobes has made it possible to study the antiseptic effect of organic acids on anaerobic bacteria by the same technique previously employed and reported in similar studies with aerobic microorganisms. These results are needed to develop the theoretical considerations of this project.

**Marine Products Research.** (C. R. Fellers.) Efforts to can either blue, sand, or rock crabs have always failed. As a result of many years of study, a successful method for the canning of Atlantic crab meat has now been perfected. The method consists essentially in stabilizing the copper present in the hemocyanin of the crab's blood and flesh by means of a protective brine dip containing small amounts of aluminum salts at adjusted pH values.

The canned meat of the blue crab contains about 18 percent of high-quality protein; it is low in fat and high in ash. Particularly notable is



the high content of essential minerals such as calcium, phosphorus, iron, copper, and iodine. The iodine content is from 400-500 parts per billion.

The meat contains moderate amounts of thiamin and riboflavin and a small amount of ascorbic acid.

The technique makes possible the establishment of an American crab-canning industry and introduces a new, attractive, tasty, and nutritious seafood to the American consumer. Four commercial canneries are already making use of this new canning procedure.

Research on crab meal for poultry feeding has been started in cooperation with the poultry department.

**Carotene Studies.** (C. R. Fellers and C. F. Dunker.) A comprehensive literature review and critique on the effect of canning, freezing, dehydration, and storage on the carotene (vitamin A) content of foods has been prepared for the Institute of Food Technologists. Collaborative studies with the U. S. Bureau of Agricultural Chemistry and Engineering on animal assays for vitamin A in frozen and canned peach products were undertaken. Excellent checks were obtained between the chemical methods for carotene and the rat bioassay for vitamin A.

**Glass Container Research.** (C. R. Fellers, K. R. Newman, and W. H. Fitzpatrick.) Extensive experimental work on loss of quality of fruit juices packed in glass containers has been carried on.

As an antioxidant in bottled fruit juices l-ascorbic acid and d-glucos-ascorbic acid are more effective than oat flour, lecithin-dextrose mixture, or tyrosine butyl ester. Thus, any free oxygen present in fruit juice quickly reacts with ascorbic acid and accordingly reduces the vitamin C content of the juice. Heat greatly accelerates the oxygen-ascorbic acid reaction, although the final total loss of ascorbic acid in bottled juices is the same after one or two months' storage, regardless of temperature. However, other quality factors are better retained in fruit juices stored at cool temperatures.

Exposure of bottled juices to artificial light also accelerates the oxygen-ascorbic acid reaction; but again, the total ascorbic acid loss in light and in darkness, over a period of a few weeks, is approximately the same and is never greater than the theoretical loss due to chemical reaction of 100 percent of the oxygen with the necessary weight of ascorbic acid, that is, one molecule of  $O_2$  combines with one molecule of ascorbic acid.

**Research on Corn Distillers Dried Grains with Solubles.** (C. R. Fellers, R. T. Parkhurst, and K. G. Shea.) This is a cooperative project with Poultry Department. Biological assays showed that this by-product is a very good source of riboflavin and vitamin  $B_1$ . While the biological value of the protein to rats is not high, when it was supplemented with casein, fish meal or meat scrap, growth was normal in every respect. For both White Leghorns and Rhode Island Red-Barred Rock hybrids, the distillers grains successfully replaced all the dried skim milk in the New England Conference starting mash at a marked saving in ration cost. Similarly, these grains could also replace about 50 percent of the fish meal plus meat scraps in the Conference Ration. The source of riboflavin and vitamin  $B_1$  was found to be dried yeast cells and lactobacilli. It is estimated that yeast and bacteria comprise about 12 to 15 percent of the weight of the corn distillers dried grains with solubles.

**Fruit Juice Concentration.** (Lowell R. Tucker.) Fruit juices were concentrated by freezing and centrifuging. Machinery was constructed in cooperation with C. I. Gunness and a method developed for small scale operation at refrigeration plants. The qualities of the fresh juices were changed very little by freezing concentration and subsequent dilution. The degree of concentration that could be obtained without serious loss of soluble solids was often limited by the viscosity of the juices. This limitation was greatest with juices from cooked fruits because of their high viscosities. Highly viscous juices, such as cooked blueberry, currant, peach, and apple, could be concentrated to two-thirds to one-half volume. Less viscous juices, as elderberry, strawberry, and uncooked apple, could be concentrated to one-third to one-fifth volume. Cooked blueberry juice treated with pectinol had its viscosity so thoroughly reduced that it could be efficiently concentrated to 45 percent soluble solids, about one-fifth volume.

## DEPARTMENT OF HORTICULTURE

R. A. Van Meter in Charge

**Propagation of Hemlock.** (Harold S. Tiffany, Waltham.) Tests on the propagation of Canadian hemlock (*Tsuga canadensis*) from cuttings were undertaken (1) to determine the effect of various constant temperatures and certain growth substances on hemlock cuttings, and (2) to secure uniform, own-root stock for fertilization experiments.

Cuttings were made up (Series I on Dec. 5-9, 1939; Series II on Jan. 30-Feb. 1, 1940) in lots of twelve for each of eighteen treatments, duplicated at temperatures of 60°, 65°, 70°, and 75° F. Temperatures were constant, maintained by electric cable and thermostat, with the exception of the 60° bench which fluctuated from 58° to 62° F. Treatments consisted of indoleacetic acid at 15, 25, and 50 mg. per 100 cc. for 16, 24 and 40 hours; indolebutyric acid in the form of Hormodin A (45 and 60 BTI units for 16, 24 and 40 hours); Hormodin Powder No. 3; and no treatment. The cuttings were placed in a medium of half sand and half peat in open benches under cheesecloth tents and kept fairly moist.

Except for slight indications (at 75° and 70° F. only) there were no rootings in check treatments. These initial rootings died before the end of sixteen weeks.

At nine weeks, a single treatment of the December cuttings (Hormodin A. 45 BTI units for 24 hours at 75° F.) showed outstandingly rapid rooting, with a 75 percent showing of fairly massive root systems. The 16-hour lot with this treatment fell to 37 percent, while the 40-hour treatment was 75 percent with less strong root systems. Since increased concentration of this treatment and lower temperature did not raise the percentage of rooting, there is a possibility that a still higher temperature with a lighter concentration would bring a higher percentage of rooting.

At sixteen weeks, 100 percent rooting resulted from thirteen treatments of cuttings in Series II. The most successful rooting (100 percent large root systems) resulted from indoleacetic acid 15 mg. per 100 cc. for 16 hours at 65° F. The percentage of rooting with this treatment fell to 90 at 70° F., and to 80 at 60° F., showing only a fair constancy for the treatment. With 24-hour immersion of the cuttings, however, this treatment

was the most consistent, giving 100 percent rooting at 60°, 65°, and 70° F.

Indoleacetic acid, 25 mg. per 100 cc. for 24 hours, was also consistent, with rootings of 100 percent at 60°, 65°, and 70° F., but with somewhat smaller root systems.

Indolebutyric acid in the form of Hormodin A (60 BTI units for 40 hours) and of Hormodin Powder No. 3 gave 100 percent rooting at 70° F.

In general, the rooting of treated hemlock cuttings was definitely accelerated at higher temperatures, but the percentage of rooting was not as high as that obtained from the same treatment at lower temperatures. In opposition to this trend, a single treatment at 75° F. gave a good percentage of well-developed rooting as early as nine weeks.

Similar trials are planned for the coming season at like temperatures with more varied treatments. Three series of cuttings will be taken from December to late February at five-week intervals.

A series of identical treatments was made with cuttings of Carolina hemlock, *Tsuga Caroliniana*, taken about December 12, 1939.

Only the strongest concentrations of indoleacetic acid solutions brought rootings of over 50 percent, requiring about five months. The response at 75° F. was negligible. At 70° F. a response of 20 to 40 percent was general from most treatments. The highest percentages of rooting came from the following treatments.

<i>Percent of Rooting</i>	<i>Treatment</i>
75	25 mg/100 cc Indoleacetic Acid 24 hrs. at 65° F.
58	25 mg/100 cc Indoleacetic Acid 40 hrs. at 65° F.
58	50 mg/100 cc Indoleacetic Acid 40 hrs. at 65° F.
67	50 mg/100 cc Indoleacetic Acid 40 hrs. at 60° F.

**Propagation of Lilac.** (Harold S. Tiffany, Waltham.) Terminal cuttings were taken on May 28, 1940, of the common lilac, *Syringa vulgaris* var. *Andenken an Ludwig Spaeth*, in lots of 75 for each treatment (except untreated lots with 15 cuttings): (1) Hormodin A solution 40 BTI units for 24 hours; (2) Hormodin Powder No. 3; (3) Formula "66"; and (4) untreated, at each of the constant temperatures, 75°, 70°, and 65° F. and an unheated bench. The medium consisted of two-thirds sand and one-third domestic peat. Cuttings were shaded by cheesecloth tents and lime on the greenhouse glass. Constant temperatures were maintained for the first five weeks only.

At the end of nine weeks the cuttings were potted. A temperature of 70° F. gave the highest percentage of rooting; Hormodin A, 99 percent; Formula "66", 96 percent; the untreated lot, 93 percent. Many of the untreated lot, however, were not sufficiently well rooted for potting. Constant temperature of 75° F. brought but one high percentage of rooting; 92 percent with Hormodin A. In general, rooting percentages mounted fairly constantly from lows with uncontrolled temperature through 70° F., and dropped decidedly at 75° F., because of burning.

All potted cuttings are in good condition with the exception of twenty-seven losses.

**Factors Influencing the Hardiness of Evergreens.** (Harold S. Tiffany, Waltham.) Plots of *Taxus baccata repandans* and *Taxus canadensis stricta*, set in the spring of 1939, received the first series of cultural treatments this season. Treatments were designed to produce widely varying types

of growth for exposure to winter and artificially controlled temperatures.

A heavy application of nitrate of soda in early May produced early rapid growth. Two applications of stable manure and late cultivation produced late, poorly matured growth. Plants receiving cultivation without fertilizer, showed a somewhat greater average growth than those in sod and also exhibited well-filled textures, while those in sod were excessively straggly and weak in appearance.

Growth measurements were taken representing average maximum terminal growth of from five to twelve plants of each species. A study of the amount of winter injury by (1) leaf count and (2) percentages of dead terminal growth with (3) cross sections of the material under the microscope will furnish indications of the degree to which growth conditions resulting from the different treatments may be related to winter-killing.

**Powdery Mildew on Garden Phlox.** (Harold S. Tiffany, Waltham.) Control sprays were not applied until mildew (*Erysiphe cichoracearum*) was fairly plentiful on the plantings of *Phlox paniculata*. Materials tested included those used in 1939 and one additional. Again, Hammond's Copper Solution, leaving no residue, and Bordeaux Mixture, leaving a somewhat objectional residue, gave best results. The use of Bordeaux 1-1-50 gave just as good results as the 2-2-50 used in the test in 1939. In 1941 a spray program from early spring to blooming time will be tried.

## DEPARTMENT OF OLERICULTURE

Grant B. Snyder in Charge

**Variety Studies.** (W. H. Lachman and G. B. Snyder.) These studies are conducted in cooperation with the Rhode Island and Connecticut Experiment Stations, to ascertain the influence of the various climatic and edaphic factors upon several strains and varieties of snap beans, celery, cabbage, tomatoes, peppers, and sweet corn. This concludes the third year of a five-year project so the data have not been summarized. Included in the vegetable plantings was Summer Pascal celery, which performed well and was of excellent quality. The Butternut pumpkin of the cushaw group yielded very well and was of high quality.

**Shape Index Studies of Tomatoes.** (W. H. Lachman.) This work has been continued with eight varieties of tomatoes, to determine the effect of climatic factors in modifying the shape of tomato fruits. Although data have been collected for four years, it is felt that more information is necessary before the results are summarized.

**Tomato Breeding.** (W. H. Lachman and G. B. Snyder.) The breeding work with tomatoes has been confined to the problem of incorporating the uniform ripening character into varieties which otherwise are very desirable. This has been relatively simple to accomplish because the uniform ripening character is evidently recessive in nature. Many lines have been obtained which are breeding pure for the uniform ripening character; but the self-pollination, which is necessary to obtain pure lines, has caused the selected progenies to segregate for other characters. The main problem now is the selection of lines which are stable for all



characters. The oldest progenies are now in the  $F_2$  generation and some of these appear to offer promise of worthwhile strains.

**Sweet Corn Breeding.** (W. H. Lachman.) Approximately 200 single plant lines have been selected from the 1600 original lines. The project was started four years ago so that many of the present lines are quite uniform in earliness, productivity, disease resistance, and quality. Many of the inbreds have exceptional vigor in relation to their earliness.

Approximately fifty of the best lines were crossed with an extremely early and productive inbred to study their general usefulness as parental material. Seed has been obtained from these crosses and will be tested in experimental plots during the coming year.

**Hybrid Sweet Corn.** (W. H. Lachman.) Seventy-one strains and varieties of yellow hybrid sweet corn were planted for trial during the past season. As in previous years many of these performed very well but were a little too late in maturing to qualify as excellent market garden varieties for Massachusetts. Of the varieties which were in the trials four are especially noteworthy: Spancross ( $C4 \times C13$ ) had only a medium-sized ear but was an extra early sort of good quality; Marcross ( $C6 \times C13$ ) was a few days later than Spancross, produced a large ear, and was very uniform in plant and ear characters; Carmelcross ( $P39 \times C13$ ) matured in the early midseason group of varieties, had a large ear, and was of excellent quality; Golden Cross Bantam was especially outstanding in the midseason class, had a large ear, was highly productive, and was of excellent quality. Ioana, which was a few days later than Golden Cross Bantam, produced well-formed ears of fair quality, filled to the tip.

**Sources of Organic Matter for Greenhouse Tomatoes.** (W. H. Lachman and G. B. Snyder.) Applications of straw, peat moss, cow manure, and horse manure have been made and incorporated in duplicate test plots in the greenhouse in an effort to obtain larger yields of greenhouse tomatoes as well as to ascertain the best source of organic matter. From preliminary observations it appears that peat moss may prove to be a valuable substitute for manure if sufficient commercial fertilizer is applied to compensate for the nutrients which are supplied in the manure. It is planned to repeat the tests several times before a summarized report is made.

**The Effects of Mulching Tomatoes and Peppers.** (W. H. Lachman and G. B. Snyder.) Various mulching materials were compared with clean cultivation for tomatoes and peppers. Straw, banana fiber, and horse manure were the materials used. Based on one season's results it appears that these mulching materials had little or no effect on the yield, percentage of cracking, or quality of fruit. Banana fiber was apparently quite effective in reducing the acidity of the soil, since these plots averaged approximately pH 7.2 while the pH of the soil from the other plots was about 5.7.

**Cultural Practice Prior to Field Setting as Influencing Yield and Quality of Peppers.** (W. H. Lachman.) Several methods of handling plants prior to field setting have been used to observe their effect on earliness, yield, and quality of the fruits produced. The Waltham Beauty strain of pepper has been used throughout the test.

Plants grown in clay pots with transplanting solution added produced a greater early yield than plants receiving any of the other treatments. Plants grown in paper pots suffered from nitrogen shortage, but applications of a weak solution of nitrate of soda appeared to correct the deficiency and these plants were among the highest yielders.

The weight of individual fruits was not greater on plots with high yields than on plots with low yields.

The addition of transplanting solutions in most cases increased the yield over the basic treatment. Transplanting solutions appeared to be quite effective in encouraging a quick replacement of roots and in stimulating early plant growth.

This project is being summarized in the Proceedings of the American Society for Horticultural Science.

#### **Asparagus Investigations.** (Robert E. Young, Waltham.)

*Varietal Improvement.* The yield records obtained for over 450 individual asparagus plants in five different lines show that the plants derived from high-yielding parents have greatly outyielded the commercial strain of seed in the trial. This is the first full cutting season for the plots. The two lines that had the greatest yield last year were the best producers again this year.

It was not possible to accurately forecast the relative rank of these lines by comparing last summer's stalk growth. Using the total summer growth for the four years, however, it was possible to forecast the rank in which the six lines would fall in respect to this season's yield. By examining the stalk count of last fall, it was also possible to pick out of all lines those individual plants which were the highest producers this year. This is a confirmation of former results obtained on the older plantings; counts of the stalk growth produced each summer show that, for the four years they have been growing, the plants produced the largest number of stalks the first year. Cutting the plants for two weeks the third year reduced the number of summer stalks remarkably. The full cutting this year did not affect the plants quite so adversely. Apparently they were better established. The variation in yield and stalk growth in any one of the five lines is not as great as that in the commercial seed.

When asparagus is compared with other vegetable crops, it can be readily seen that considerable progress must be made before a variety of asparagus can be established that would be comparable in uniformity of performance to other vegetable crops.

*Depth of Planting and Height of Cutting.* This project has been completed and the most pertinent results published. Results of practical value to asparagus growers are:

1. Deep planting reduced stand, mostly in the first and second years.
2. Deep plantings were slower to produce in the spring.
3. Asparagus crowns sought the level best suited for their needs. Many of the shallow-rooted plants went down and the deep-planted roots became more shallow. The average for all plots was 4 to 4½ inches from soil level to the top of crown.
4. Cutting the spears with 4 inches of green, which is the length of asparagus tips sold on some of our markets, did not give as high yields per plant as cutting the spears with 8 inches of green, the way most growers cut.
5. Allowing the spears to grow to 12 inches of green increased the yield

slightly but, of course, reduced the number of spears, and would probably bring the grower less returns. The important point in this connection is that cutting the spear with 12 inches of green did not exhaust the plant, as many growers expected. The yield relationships remained about the same throughout the experiment.

The results of this experiment would suggest the following recommendations:

1. Plant crowns 4 to 6 inches deep—shallower on heavier soil.
2. Cut spears with 7 to 8 inches of green for highest returns from the asparagus bed.

**Vegetable Breeding for Improvement of Quality.** (Robert E. Young, Waltham.)

*Lettuce, New York Type.* (In cooperation with United States Department of Agriculture.) The breeding work to develop a better adapted lettuce has progressed satisfactorily during the year. The new dark green selections found last year proved to be very desirable. They have dark green color, head well, are very crisp, and have a low percentage of tip burn. The one character that is not satisfactory at present is that most of the heads are not round but slightly flattened. Round-headed selections were made this year in an attempt to remedy this condition.

These selections are still segregating and will not be ready for release for a few more seasons. However, during the last trials, the best selections produced approximately three times as many marketable heads as did the best commercial strain. One further advantage is that most of the crop can be cut at one time.

The necessity of having a large number of selections from the better strains was further emphasized this year. Of the ten selections that were grown from last year's best strain two were of no value, two were only fair, and six showed varying degrees of heading.

Aster yellows, the disease that affected much of last year's crop generally in this section and destroyed 85 percent of the selected plants, was very mild this year. Not over 5 percent of the selections were affected. The reason for the variation in the severity of this disease has not been determined but it probably depends on the number of leafhoppers that live over winter.

*Greenhouse Lettuce.* The second generation of a cross between Bel-May, our regular greenhouse lettuce, and a dark green English lettuce was produced this year. The segregation of characters of this cross was very favorable to selecting the desired type. Twenty plants were saved and seed produced. It will require several generations to produce a uniform strain.

The supply of stock seed of Bel-May was replenished in the greenhouse under controlled conditions, with the expectation of eliminating the 3 or 4 percent of plants that are dwarf and mosaic-like although the exact nature of this trouble has not been determined.

*Celery.* Seed of the Summer Pascal celery was readily available and most of the local celery growers tried it. This celery has been generally accepted and is considered a big step forward in the production of a quality crop. Improvement in some of the characters is still needed, and toward this end seed from 20 individuals was grown and carefully noted. Three of this lot were considered superior and further selections were

made. Selected plants were also saved to supply the immediate need for stock seed.

Attempts to speed the breeding program by sending plants to Puerto Rico to to be grown there failed because of heart-burn in the plants which became so severe they died.

*Tomatoes.* Growers of trellis and greenhouse tomatoes have used and appreciated the two strains of tomatoes (Waltham Forcing and Trellis No. 22) developed at the Field Station. Many have expressed a desire that we continue our work and attempt to remove the two or three undesirable characters they contain. In this connection, crosses were made in the greenhouse using Waltham Forcing, Trellis No. 22, and Early Trellis as one parent and Marglobe, Early Rutgers, and Michigan State Forcing as the other. These hybrids were grown last season in comparison with many strains of Comet of local seedsmen and, of course, the parents of the crosses. The hybrids showed pronounced hybrid vigor, producing more early fruit and a greater total yield. The hybrid vigor was so pronounced, and growers' comments about them so enthusiastic, that an attempt will be made to produce a small amount of hybrid seed for growers' trials. The large percentage of No. 1 fruits produced by our strains of tomatoes was also exhibited by the hybrids. Under intensive cultivation where the value of an acre of tomatoes is very high, the expenditure of \$10 to \$25 per acre for seed that will increase production from 15 to 25 percent would be within the reach of many of our growers.

Selections were made from the hybrid material to carry on the breeding program as originally started.

*Rutabaga or Cape Turnip.* The improvement program with Cape turnip was not greatly furthered during the year because the selected turnip plants failed to set seed in the greenhouse, and because what crop was planted outside was almost completely destroyed by cabbage maggot. Seed from other selected roots of the year before will be used for next year's crop.

*Hutchinson Carrot.* The improvement of the color and core of the Hutchinson carrot by hybridization is becoming more important as local consumers become more accustomed during the winter to carrots from other producing areas. The varieties used in other areas are not suited to our soil and are very susceptible to carrot blight.

The third generation of a cross between the Hutchinson and a Red Turkish carrot was grown this past fall and several lines were selected that were quite uniform and desirable. The biennial nature of carrots makes the breeding program slow.

Selection within the Hutchinson carrot to improve the strain has also been continued.

The supply of stock seed of the Field Station strain of Hutchinson carrot was replenished. The demand for this stock seed has been so great that it has been necessary to limit the quantity to 1½ pounds per seedsmen.

*Waltham Beauty Pepper.* During the year a comparison was made between open-pollinated selections and the same plant self-pollinated in the greenhouse. While the characteristics of the population did not differ greatly and crossing in the field might not be visible, there was no detectable difference in the two lots of seed. Very few of the hybrids have shown the fruit setting ability of the Waltham Beauty and not shown the un-



desirable character of being hard to pick. About 25 lines were grown and many were discarded as undesirable.

*Wyman Crosby Beet.* The seed crop of this beet, which was to be sent to growers for trial, was almost a failure. As the seed becomes available, it will be put on trial.

Of the 12 self-pollinated lines grown this season, 2 were definitely outstanding as to internal color. Several were discarded because they were too light in color.

A change has been made in the technique of growing and selecting the best beet roots to better show up those specimens lacking in proper color. This different method will also speed up the program through the production of seed in the greenhouse.

*Green Sprouting Broccoli.* In the spring crop of broccoli 14 selfed, selected plants were compared to the 15 best commercial lines. There has been extreme variation in the time required for broccoli plants to produce a head, but comparing the two groups as a whole there was not much difference in their behavior. At the time of the first cutting, 33 percent of the plants in each group were harvested. In some lines in the selected group, as high as 85 percent of the plants were harvested. In the best commercial line, less than 50 percent of the plants were cut. Three weeks later, at the time of the last cutting, less than 5 percent of the plants in the best selection had not matured a head. This planting demonstrates the need for a better strain, and many selected plants were lifted from the field and self-pollinated.

Some of the same seed used for the spring crop was planted for fall. The best lines in the spring crop were not the best in the fall, indicating the need of two strains for the two seasons. Hybrids have been made between some of the best types and the early, poorly headed types obtained from Italy. Growers have contributed strains on which they have done work, and crosses have been made with these types to provide a redistribution of characters.

*Greenhouse Cucumbers.* During the year the work with cucumbers has been to collect all the desirable types possible from local growers and seedsmen which were not on hand from last year. These lines were grown in the field and self-pollinated to true up the lines before hybridization work. Mosaic was very severe in the field and only the early fruits were of value. A spring crop was grown in the greenhouse and some of the lines tested. From the vigor and yield of one hybrid under trial, it would seem that hybrid seed which growers could produce themselves would solve the problem of a better cucumber. The work of determining the best parents for such a cross will be continued in the greenhouse and field.

*Rhubarb.* In an attempt to find a better forcing rhubarb, a collection of varieties has been assembled and preliminary forcing studies made in one of the growers' forcing houses. Some of the strains had better color than Victoria, the variety generally used locally, but most of the strains did not have high yield. Keeping quality after harvest was studied and it was found that wrapping the rhubarb in moisture-proof cellulose sheets prevented deterioration. Further study on the variety problem is needed.

## DEPARTMENT OF POMOLOGY

R. A. Van Meter in Charge

The past season was a reasonably favorable one for fruit crops. There was abundant rainfall in the early part of the season but the late summer and early fall were dry with much abnormally cool weather. The apple crop was good considering the heavy crop of 1939. There was some injury to the crop from freezing weather during the latter half of October. Peach buds survived the winter in adequate numbers and there was little cold injury to raspberry canes. Blueberry plants suffered more than usual.

**The Influence of Various Clonal Rootstocks on Apple Varieties.** (J. K. Shaw and L. Southwick.) Some of the stocks in the stool bed are dying, but Malling II, III, IV, XII, A, and C are still in fair to good condition. A new stock bed was set containing from 25 to 100 each of 21 clonal stocks. A part of the more valuable stocks were set upright for stooling and the rest set on an incline for laying down along the row. No rooted layers will be taken this year but the plants will be cut back in the spring, giving them time to gain vigor before being subjected to cutting.

Some of the cooperative clonal stock orchards are doing very well and others are failures, owing, in some cases, to unfavorable soil conditions and in others to poor management or neglect or perhaps bad luck. One new orchard of about 400 trees was set near Three Rivers.

The clonal stock orchard set in 1937 made excellent growth and a few trees bore good crops. Baldwin grew more on Malling I and IV than on Malling XV and Malling XVI, but Golden Delicious grew more on Malling XVI than on Malling V. Usually trees on semi-dwarfing stocks grow about as rapidly as those on standard stocks but begin to bear earlier, and this checks growth. Trees on very dwarfing stocks may grow less rapidly from the start and are likely to prove useful only in home gardens.

The McIntosh and Wealthy orchard set in 1928 became crowded and most of the Wealthy trees were pulled out, leaving a few scattered trees for pollination. Two plots running across the rows received a hay mulch to see how this affects the trees on different stocks, this treatment having given very favorable results in an adjacent orchard on seedling roots.

The larger orchard of 900 trees, set in 1939, made fair growth and the loss of trees from various orchard ills has thus far been very small. They are being grown under strip cultivation with mulch around the trees. All the Malling stocks in our stock collection, except VI and VII, are represented. The smaller orchard of 55 trees suffered from breakage of the tops and all trees were cut back and made a good whip growth.

A survey of the average growth as measured by trunk diameter fails to show any effect of the dwarfing stocks during the first two years of growth in the orchard. Trees on Malling III and IX have grown more than the same varieties on the "standard" Malling stocks in as many cases as they have grown less. The dwarfing effect will appear at fruiting, and possibly before, with some combinations.

Another interesting observation is that the yearling whips have increased in diameter at least as much as the trees that were two years old at setting, which supports the belief that one-year trees will reach bearing size as soon as two-year trees.

**Tree Characters of Fruit Varieties.** (J. K. Shaw, A. P. French, O. C. Roberts, and L. Southwick.) This was the twentieth year of nursery examination for trueness to name. A group of 18 nurseries has been visited annually for five years, one of them for all the 20 years. While the number of misnamed trees decreases with repeated examinations, few nurseries escape introducing a few misnamed trees. About the usual number of trees was certified by the Massachusetts Fruit Growers' Association.

The introduction of clonal stocks into the nurseries presents a new problem. Unless the stock is identified before cutting back after budding, it will be difficult or impossible ever to know certainly what stock is under the trees in the orchard. It would be entirely possible to examine the stocks before or after budding and the budded trees the next year and then certify the identity of both stock and scion variety when the trees are ready for sale. Something of this sort should be undertaken or great confusion and uncertainty will arise when and if trees on clonal rootstocks come into use.

The cherry variety nursery of about 45 varieties presented an opportunity for study, and descriptive notes and photographs were secured for publication. All the distinct varieties can be identified in the nursery row.

A pear nursery, including nearly all the varieties found in nurseries in this section of the country, was started. While most pear varieties are rather easily identified, there are a few that require closer study than can be given in nursery visits.

Some study was given to a collection of about 60 peach varieties, and most of them were rebudded for further observation directed toward the difficult problem of identifying peach varieties.

**The Genetic Composition of Peaches.** (J. S. Bailey and A. P. French.) During the year this project was redirected and rewritten to bring it more in line with work actually in progress. Data obtained during the year indicate that : (1) Genes F (free), M (melting), s (albino), and St (soft melting flesh) are linked in that order, and (2) M is 15 units from F, c 35 units from M, and St 5 units from c.

**Comparison of Cultivation and Sod in a Bearing Orchard.** (J. K. Shaw.) No change was made in the soil treatment in this orchard, which has been under experiment for 20 years. Additional mulch to a depth of 1 to 2 inches was applied to plot 3 as in the previous two years. The trees are vigorous, with good foliage color and no signs of nitrogen deficiency, despite the fact that no nitrogenous fertilizer has been applied for 20 years. Attempts to harrow in the decaying mulch have not been too successful. Some mixing of the soil and hay has occurred and in this surface layer small rootlets from the apple trees are readily found. This fact is considered to be very significant and may explain in part the surprising apparent response of the trees in growth and fruiting.

Yields and growth of this orchard in 1940 have not yet been compiled, but yield was much lower than the record crop of 1939. As previously mentioned, two additional plots in a younger adjoining orchard were mulched for the first time this year. In all three of these plots, the mulch was applied to cultivated soils reasonably free from grass and weeds. Experience with them suggests that in starting a full mulching program, it may be wise to suppress grass and weeds by cultivation before the mulch is applied.

Determinations of loss on ignition as a measure of organic matter indicate that there is more organic matter in the soil of the sod plots than of the cultivated plots, especially in the 6 to 9 inch level except in cultivated plot 7. This plot is lower and wetter, and therefore the soil is less well aerated and the decomposition of organic matter proceeds more slowly. This determination will be repeated later to measure any changes that may appear.

**Comparison of Cultivation and Heavy Mulching for Apples.** (J. K. Shaw.) No additional mulch was applied either to the block of mature Wealthy or to the old McIntosh block now planted to young Wagener and Rhode Island Greening trees. The decaying mulch is now 6 or 8 inches deep and should be sufficient for several years to come even though grasses, mostly quack grass, have grown up through the mulch. The trees continued to grow and produce well, and no injury from mice or fire has yet occurred. Networks of fine fibrous rootlets abound in the upper layer of the soil just below the decaying mulch. Both cultivated plots were fertilized with a nitrogen-potash mixture.

**The Effects of Fertilizer Limitation on Fruit Plants.** (J. K. Shaw.) The trees planted in 1931 have been removed and the experiment terminated for a time at least. The data await study and evaluation. The general result is that factors other than the fertilizer applications have greatly affected the growth of the trees.

**Effect of Potash and Lime on Apple Trees.** (J. K. Shaw.) This orchard was pulled out last winter and the experiment ended. The data accumulated in the past 20 years will be studied this winter. The area was seeded to rye in early fall. It is interesting to note that while the addition of phosphorus to nitrogen and potash did not improve the performance of the trees, the presence of phosphorus is the determining factor for good growth of the rye. One corner of the orchard had no fertilizer during the 20-year period, yet the rye grew almost, if not quite, as well as on the nitrogen-only plots. The addition of potash to nitrogen improved growth slightly; but on all plots which had received phosphorus with nitrogen, with potash, or in a complete fertilizer, growth of the rye was excellent.

**Study of Varieties of Fruits.** (J. K. Shaw and Staff.) The usual observations of the behavior of many of the newer varieties of fruits were made. A new orchard of peach and cherry varieties was set in early May, 1940, on contours on a moderately steep slope. It contains from two to five trees each of 67 new and old varieties.

**Apple.** Two red variants from the Pacific Northwest have fruited. The Seando Red Rome this year was much inferior in size and color to Gallia. The latter is often sold as Red Rome but all trees under the name Red Rome may not be Gallia. Shotwell Delicious closely resembles Richared but is possibly a little darker in color.

Stamared is a sport of Stayman, dark red, obscurely striped and splashed. Otherwise, it is like Stayman and the nursery trees cannot be distinguished. It is promising for anyone who wants a highly colored Stayman.

Two varieties from the Prairie Northwest also have fruited. Sharon, of Iowa origin, resembles Duchess in color and has a firm juicy flesh but



little flavor. Haralson has fruited for several years. It is a large round conic apple, lacking in quality. We have elsewhere stated it to be of Iowa origin, whereas it originated in Minnesota.

Four new varieties from Canada have recently begun to bear. Macross is a McIntosh seedling and the tree bears considerable resemblance to that variety. It is a roundish, dark red apple with obscure stripes and splashes. The flesh shows some reddish streaks. It is a little earlier in season than McIntosh, juicy, and of good quality. Hume is another McIntosh seedling of about the same season as Macross. It is dark red, splashed and striped, with a melting flesh of very good quality and a peculiar, rather agreeable flavor. Both of these are promising varieties and worth trying. Edgar is still another seedling of McIntosh crossed with Forest. It is later in season than McIntosh, which it resembles, though somewhat inferior to it in color. The flesh is juicy and good but not equal to McIntosh. Linda is a late winter apple, roundish, of an attractive red color and crisp, juicy flesh.

Cox Orange is a variety well known in England and is grown in Nova Scotia for export to English markets, where it is highly esteemed and brings a high price. The tree is somewhat lacking in vigor but bears fairly well. The apple is rather small, oblate conic, yellow partly covered with a bronze red, and not attractive in appearance. The flesh is subacid, crisp and melting, with a very good, spicy flavor. Perhaps it is not at its best here, but it is easy to see why it is valued by lovers of choice apples. It does not look promising for commercial use but might be desirable for the home garden.

Anoka is from South Dakota, is very hardy, and resembles Duchess. It is remarkable only for its dwarf growth and for coming into bearing very early.

Yates has been grown to see how a variety from the extreme southern apple region would behave here. It proves to be a small, smooth, oblate apple, with conspicuous dots and very poor flavor—an extreme case showing what happens when a variety is grown far from home.

*Peach.* New varieties of peaches are added to our variety orchards each year. Most of them prove unsuited to our conditions or not superior to established varieties of the same season of ripening. Yet such trials must be made if we are to find the occasional variety that is really an improvement. The following comments on a few varieties are based on one or more years observation in our orchards supplemented with what we have learned of their behavior elsewhere.

Ambergem is a good tough-fleshed clingstone canning peach two to three weeks earlier than Elberta. It is meeting with favor in eastern canning districts; but as we have no canning industry, it will not be planted here.

Candoka is a medium large, round, yellow-fleshed freestone peach of Elberta season or a little later. It is characterized by a red streak down the suture. The flesh is firm melting and of poor quality. It seems to have little or no value for us.

Hardee is a large, compressed, yellow-fleshed freestone peach, a little later than Elberta, unattractive, of poor quality, and of little or no value for us.

Polly resembles Champion closely, ripening a little ahead of it; white-fleshed, soft, freestone of not too good quality—not promising.

Sunglo is said to be an improved South Haven. With us it has shown little superiority, and considering that there are other excellent varieties of this season, it is doubtful whether it finds a place.

Sungold is a large, firm, freestone, yellow-fleshed peach of Elberta season; not very attractive and of only fair quality.

**Fruit Bud Formation in the Strawberry.** (R. A. Van Meter.) In 1939, twenty plots of 300 plants each, involving four treatments, were established to study the relation of time of mulch removal to the performance of fruit buds. An abnormally late, cold spring tended to eliminate the effects of differential treatments to such an extent that the trial is being repeated.

Twenty plots of 200 plants each were established in 1940. These were given differential treatments as follows:

1. Light mulch to be removed early.
2. Light mulch to be removed late.
3. Heavy mulch to be removed early.
4. Heavy mulch to be removed late.

It is expected that observations on these plants next spring will bring this phase of the study to an end.

**Bud Mutations.** (J. K. Shaw and W. H. Thies.) The collection of 20 bud selections of McIntosh budded last year served as a source of material for a new project elsewhere outlined. Trees of all 20 lots will be set for orchard observation.

Most of the bud sport selections top-grafted in 1930 have borne fruit. A solid red selection of McIntosh from our own orchards shows no signs of stripes or splashes, but all selections color about equally well. The selections from Wealthy differ very slightly if at all. Among the Baldwin selections, one which produced ill-shaped apples with a tendency to a five-lobed form maintains this character but is of no commercial value.

The most marked variation is among the Gravenstein selections. Scions from a "flat limbed strain", which did not show the malformation up to 1935, now show it, not only in the selected graft but on other branches in the same tree grafted with normal wood. It does not appear on two other top-worked Gravenstein trees in the same orchard. This suggests that this abnormality may be transmissible and possibly caused by a virus. One of the selections of Gravenstein for high color is rather exceptional and is being propagated for comparison with the Washington type now in cultivation. None of the other selections were much superior to the common striped type and some could not be distinguished from it. These observations are in harmony with the belief that Gravenstein more frequently shows bud mutations than other common varieties grown in Massachusetts.

**Storage of Apples in Modified Atmospheres.** (O. C. Roberts and L. Southwick in cooperation with Engineering Department.) McIntosh apples were stored in 40-quart milk cans from harvest time in 1939 until February 1940. It is probable that the cans were not gas tight, for the oxygen content in no can fell below 8 percent. No attempt was made to remove CO<sub>2</sub> which rose to a maximum of 16 percent with an average varying between about 5 percent and about 12 percent in different cans. McIntosh stored September 25 at 60°-65° F., in roughly 12 percent CO<sub>2</sub>

and 10 percent oxygen, were ruined by scald; while others stored at 40° F. came through in excellent condition. Those stored October 11 in a similar atmosphere at 60°-70° F. rotted completely; while those stored at 40° F. were in excellent condition February 1.

Experiments are being continued with the cans tightly sealed by soldering a metal disc in the mouth of the can and metal tubes in the top and bottom for gas sampling and introducing gas for modifying the atmosphere in the can. Different levels of nitrogen, oxygen, and CO<sub>2</sub> will be maintained by controlled respiration, introduction of nitrogen gas, and "scrubbing" to remove CO<sub>2</sub>. As the experiment is still in progress, no results can be reported at this time. The oxygen content decreased rapidly after the cans were sealed.

One of our small refrigerated storage rooms was gas-proofed, and 191 bushels of apples, mostly McIntosh but including other commercial varieties, put in the room, which was sealed on October 11. Brine coils on one side of the room made it impossible to fill the room as full as desirable, and the consumption of oxygen through respiration has been less than hoped. The oxygen has fallen (December 16) only to around 13 percent, while the desired content is 2 percent. Evidently, gas-tight rooms must be filled at least to 80 percent capacity if the oxygen is to be reduced satisfactorily by respiration of the apples. The temperature is kept near 40° F. and apparatus devised for "scrubbing" the storage air to reduce the CO<sub>2</sub> content. The behavior of the apples in the cans, which are absolutely gas-tight and filled to capacity, shows that under these conditions the respiration of the fruit reduces oxygen and builds up CO<sub>2</sub> in a short time. Under the usual conditions of storage, it is impossible to fill a storage room completely full and difficult to make it completely gas-tight.

If storage of McIntosh in a modified atmosphere at higher temperatures than is usual in cold storage works out as investigations elsewhere promise, it will bring about a new situation in our apple industry.

**Study of "Bud Sports" of the McIntosh Apple.** (J. K. Shaw and L. Southwick.) This is a new project. It is natural to suppose that a type of McIntosh that is uniformly red all over with no sign of stripes and splashes is, in other respects, no different from other types of the variety. Yet it may be inferior in vigor, productiveness, or other respects and be undesirable for orchards in spite of its superior color. This project is planned to learn the truth about this. Six strains of McIntosh, believed to be of distinct origin, have been budded and will be planted in an orchard so planned as to make possible accurate measurements of any differences between the strains that may exist.

**Tests of Spray Materials.** (O. C. Roberts.) As in previous years, tests of several insecticides and fungicides were made in cooperation with the Departments of Entomology and Botany. A report of the season's work may be found in the report of the Department of Entomology.

**Nutrition of the Highbush Blueberry, Especially in Relation to Soil Reaction.** (J. S. Bailey.) On January 16, 1940, a series of sand cultures was set up to determine the deficiency symptoms of blueberry plants when various elements are left out of the nutrient solution. This experiment was concluded June 26, 1940. Kodachrome color slides were made of plants, showing the effects of omitting from the nutrient solution N,

P, K, Ca, Mg, or B. One of the most striking results was the reaction of the plants to the acetate ion when it was substituted wholly or in part for the sulfate ion. The plants stopped growing and the leaves became very chlorotic. When the chloride ion was substituted for the acetate ion, the plants partly recovered.

In cooperation with Dr. Linus H. Jones of the Department of Botany, blueberry plants were grown in the soil temperature tanks at 55°, 60°, 65°, 70°, 75°, 80°, 85°, and 90° F. from February 19, 1940, to June 18, 1940. The following results were observed: (1) the plants at the two lower temperatures wilted during the first few days but later recovered; (2) total linear growth and height growth increased as soil temperature increased; (3) plants at 70° F. or higher tended to grow tall and upright; those below 70° F., shorter and more spreading. A report of this work will appear in the **Proceedings of the American Society for Horticultural Science for 1940.**

**Blueberry Culture.** (J. S. Bailey.) During the winter of 1939-40 there was considerable winter injury to the tops of blueberry bushes in the Experiment Station plantings. Although all varieties were injured to some extent, Rubel was injured much worse than any of the others. The cause of the trouble was probably a dry fall followed by cold, dry, north and northwest winds during the winter. The month of November was unusually dry. There were three weeks with no rain just before the ground froze. A frozen dry soil with cold, dry winds proved to be a bad combination for blueberries.

The Italian ryegrass, planted as a cover crop in 1939, was found to be a mixture of Italian and perennial ryegrass. It made a very good growth in most of the field and consequently furnished considerable organic matter, but it was rather difficult to subdue by cultivation the following spring. A further test of cover crops was started in the summer of 1940. Three special lots of seed were received from the Soil Conservation Service: (1) No. 3297 *Bromus arvensis*, field Brome grass; (2) No. 3197 *Lolium perenne*, perennial ryegrass; and (3) No. 2965 *Phleum pratense*, timothy. These were compared with oats and rye. Good stands of oats and rye were obtained, a fair stand of perennial ryegrass, a poor stand of field Brome, and practically no timothy.

During August, scion wood of the following blueberry selections was received from the U. S. D. A.: DN-76, AW-34, A-91, BM--22, T-72, R-86, L-25, AR-64, X-58, V-20, U-85, V-25, and AW-35. These were budded into Rubel plants in Row A, Plot C.

Plants of the newly named Pemberton variety yielded berries of exceptional size, very attractive appearance, and very good flavor. Berry size held up well throughout the season. The Concord variety bore an unusually large crop of large attractive berries this year.

The blueberry mite was observed for the first time in the College blueberries. It was not abundant and will probably never be a serious pest.

**Premature Dropping of McIntosh Apples.** (L. Southwick.) Work on this project was reported in Bulletin 372, published in May 1940. The best suggestions that could be made—such as increasing seed number by better pollination, lowering nitrogen in the tree thus decreasing vigor, thinning at the critical time, and spot picking—seemed either impractical or not effective enough. Unfortunate choice of soils favoring drop



cannot be much alleviated though such soils should obviously be avoided in planting new orchards.

In 1939 the use of hormones was suggested and limited trials made that year gave some encouragement that they might have value. In 1940 several commercial preparations carrying these hormones came on the market, and the manufacturers supplied these materials which, with the pure hormone naphthalene acetic acid, were used in more extended tests. The usual concentration was 10 parts per million, but lower concentrations, and in one case a higher concentration, were used. Unsprayed check trees were used in all cases. Comparisons were made in nine orchard blocks on McIntosh, Baldwin, Wealthy, Duchess, and an unknown variety which always drops badly. Drops from each tree were gathered and counted, generally daily, and the numbers of apples picked were calculated. With Duchess and the unknown variety the spray was very effective, holding the apples until past the proper picking time while apples on the checks dropped heavily. With Wealthy and Baldwin the material was not very effective.

Most of the comparisons were on McIntosh, and effectiveness varied in the different tests. It appeared only on computation of the actual percentage of apples dropping. In some cases the effect was very small and in others it was marked, apparently preventing as much as 60 percent of the drop when picking was delayed. The effect appeared first about two or three days after the application and continued around ten to twelve days. About 15 to 35 gallons per tree, according to its size and crop, were applied. Concentrations of less than 10 p.p.m. seemed less effective, suggesting that until further investigation, it is unwise to apply at less than recommended strength.

It is doubtful whether many of the trials on McIntosh checked drop enough to be commercially profitable. It should be remembered that drop was much less in 1940 than usual. It is probable that in a year of normal or excessive drop the use of hormones would be more profitable.

The size of the crop on the trees is perhaps the most important factor in determining the profit from hormone spraying. With a heavy crop the number of bushels saved would be larger while the expense involved would be little more than with a light crop.

Our present feeling is that a McIntosh grower should have a supply of the material on hand and if warm moist weather prevails as harvest approaches, and especially if apples have not sized and colored sufficiently, he should apply it as soon as dropping becomes marked, even if he has to take some of his best pickers for the job. Our experience this year does not warrant any preference for any of the commercial preparations. All are presumed to carry practically the same content of hormone and differ only in the carrier, which may or may not affect the effectiveness of the hormone.

#### Miscellaneous Work

**The Use of Peat in Planting Apple Trees.** In May 1939, a small experiment was set up to test the effect of granulated peat on newly set trees. Twenty-six trees (mostly one-year whips) were planted in the usual manner. For an equal number of trees, each tree being paired with a check tree, the soil for planting was thoroughly mixed, 50-50, with twelve quarts of wet peat prior to setting each tree. Several varieties and rootstocks were represented. The peat had been used during one season for propagation purposes and was not strictly comparable to fresh

peat. The paired trees were set between the trees in a newly planted orchard in four locations representing different degrees of soil depth, fertility, and moisture. Pruning was intentionally severe. All trees were cut back to 2-3 feet and the laterals removed.

Neither during the summer of 1939 nor during the summer of 1940 could any consistent differences in growth be detected in the field. Measured by trunk diameter, the check trees apparently have grown as well as the trees planted with peat moss. On three out of the four locations the treated trees grew slightly more but the differences are not significant.

Other work, notably at the New York Agricultural Experiment Station, has shown good results from the use of peat moss at planting time. Peat favored root growth and spur development. Since it is possible that trunk diameter may not accurately reflect total growth, it is planned to make further studies for any possible effects from the peat treatment. Then, too, there is the possibility that peat used in propagation frames for a season may not be as effective as "fresh" peat. There is no doubt that peat favors rooting under many circumstances, perhaps through improved aeration of the soil. Other investigation has shown that the best results are obtained in seasons with excessive soil moisture in the spring followed by drought conditions in midsummer.

It is suggested that as far as planting in Massachusetts is concerned, the natural soil and the site are the important factors. A poor orchard soil is extremely difficult to improve sufficiently for maximum tree performance. The use of peat in the planting operation does not seem necessary on a good soil, though it may prove helpful in some instances.

**Soil Acidity in the Orchard.** Repeated applications of sulfur sprays and dusts may cause an increase of soil acidity injurious to grass or cover crop and possibly to the trees. Samples of the top three inches of soil were taken from beneath a McIntosh tree growing in sod, which had been sprayed following the current schedules for over 20 years. Lime-sulfur was most used but wettable sulfurs and sulfur dusts have been increasingly used. Results were as follows:

<i>Distance from trunk, feet</i>	<i>pH Value</i>
4	4.50
9	4.80
15 (under branch tips)	5.08
20 (midway between trees)	5.60

The steady decrease of pH values, and therefore increase of acidity, towards the trunk is interesting. Probably sulfur sprays tend to run down and drip from the main branches; also when the trees were small, only the more central part of the area was subject to spray drip. The soil near the trunk is ten times as acid as that outside the branch tips and is too acid for many crops. While apple trees are quite tolerant of acid conditions, they may suffer at least indirectly from acid conditions such as these.

Another case of possible soil toxicity in a Sudbury orchard was called to our attention. A visit to the orchard showed that many trees were not vigorous and the grass and weeds under such trees were dead. The line of demarkation under the tips of the branches was sharp. The trees

had been sprayed during this season with cryolite and it was estimated that about two pounds per tree had been applied. Cryolite contains, in addition to fluorine, considerable aluminum. Samples of the top soil were taken under four trees where the herbage was dead, together with check samples taken near by but between the trees where herbage growth was good, also similar samples taken beneath and outside a more vigorous tree with good grass beneath. Determinations of pH value and easily soluble aluminum were made by Professor Everson of the Department of Agronomy. The pH value varied from 3.98 to 4.62 and averaged 4.31; there were no consistent differences between the samples from the different locations. On the other hand, the soluble aluminum was rated as "very high" on all the samples taken where the herbage was dead and only "medium" or "high" in all cases where herbage was good. The pH value 4.50 is considered to be on the border line; below it there is danger and above it less danger of aluminum toxicity. It may be that the addition of aluminum from the spray was enough to increase the aluminum so that a toxic condition prevailed. Of course, a moderately heavy application of lime would correct such a condition.

## DEPARTMENT OF POULTRY HUSBANDRY

R. T. Parkhurst in Charge

**Broodiness in Poultry.** (F. A. Hays.) Efforts are still being made to develop a genetically non-broody line of Rhode Island Reds by selective breeding using aged breeding stock. Birds for breeding are selected not only on their performance record but also on the broody behavior of their daughters.

A recent report on the inheritance of broodiness (Bul. 377) confirmed previous findings that degree of broodiness as measured by the number of broody periods is inherited. This study showed further that deferred broodiness was an important characteristic in dealing with the broody problem. Females exhibiting broody behavior first in the second or third laying year transmitted the broody instinct to about as many daughters as did females that expressed the broody instinct in their first year of laying. Rather definite evidence was presented to indicate the complete absence of sex-linked factors affecting broody behavior in Rhode Island Reds.

**Statistical Study of Heredity in Rhode Island Reds.** (F. A. Hays and Ruby Sanborn.) This project is devoted entirely to the preparation and analysis of experimental data for publication. During the year the following papers have been prepared: Inheritance of Broodiness in Rhode Island Reds, Station Bulletin 377; Color Markings in Rhode Island Red Chicks as Related to Sex and Adult Color, Jour. Agr. Res. July, 1940; Breeding Small Flocks of Domestic Fowl for High Fecundity, Poult. Sci. 19 (6), 1940; Transmitting Ability in Males of Genes for Egg Size, Poult. Sci. in press; Sex Ratio in Domestic Chickens, Am. Nat. in press; and Correlation in Egg Weight Between Mothers and Daughters, Jour. Hered. in press.

**A Genetic Study of Rhode Island Red Color.** (F. A. Hays.) Two lines of Rhode Island Reds are being developed in a study of the mode of inheritance of plumage color and the relation of plumage color to char-

acters affecting egg production. One line is bred for early sexual maturity while the other is bred for late sexual maturity. This phase of the project is rather recent, but there is some evidence that the extremely dark shade of plumage demanded in exhibition birds is in part associated with the age at which sexual maturity is attained.

**Rate of Feathering in Rhode Island Reds.** (F. A. Hays.) The major objective of this experiment is to develop two lines of birds differing with respect to feather development on the back at eight weeks of age. A third line used as a check consists of stock bred for high fecundity with but limited consideration given to rate of chick feathering. Because of a striking sexual dimorphism in the sexes for rate of chick feathering, it is essentially impossible to classify female chicks at any age for rate of feathering on the basis of feather development over the back; therefore, attention has been directed largely to the males.

Line 1 has been sired exclusively through six generations by males with complete back feathering at eight weeks. Line 2 has been sired through the same period entirely by males having no back feathering at eight weeks. The check line was sired by varying proportions of rapid and slow-feathered males. The sixth generation gave the following percentages of rapid-feathering sons in 1940: line 1, 59.0; line 2, 2.2; and the check line, 28.4. Results to date indicate that rapid chick feathering in Rhode Island Reds depends on a series of recessive genes. A sex-linked gene for rapid feathering may be present, but many males having complete back covering may lack this gene. Up to the present time no important differences have been observed in the three lines with respect to characters affecting egg production.

**The Effectiveness of Selective Breeding to Reduce Mortality in Rhode Island Reds.** (F. A. Hays.) Cooperative project with Regional Poultry Research Laboratory, East Lansing, Michigan. The sixth generation of birds in this project completed their first laying year in the fall of 1940. In the low-mortality line 135 chicks were hatched in this sixth generation and their total mortality to six months of age was 6.6 percent. In the high-mortality line 153 chicks gave a mortality at six months of 10.46 percent. No losses from the paralysis complex were observed.

Forty-four pullets from the low line and forty-six from the high line were placed in the laying houses in September 1939. At the same time all of the brothers of these pullets were housed for the winter. There were 41 males in the low line and 47 males in the high line. Mortality records are complete for 11 months under these conditions. In the low line the mortality in pullets was 47.7 percent and in the high line 21.7 percent. The loss of males in the low line was 14.6 percent compared with 51.1 percent for the high line. For the total population, the losses were 31.8 percent in the low line and 36.6 percent in the high line.

Cannibalism was rather severe in both lines. If the cases of death apparently from cannibalism are omitted, the losses in the high and low lines were: Pullets, 20.4 percent and 13.0 percent; Males, 12.1 percent and 46.8 percent; Sexes combined, 16.4 percent and 30.1 percent. No appearances of diseases of the paralysis complex were observed in either line. The data appear to suggest that the males of the high-mortality line were decidedly less viable than the males of the low-mortality line. Why the losses in the females should fall in reverse order is not clear.



**Genetic Laws Covering the Inheritance of High Fecundity in Domestic Fowl.** (F. A. Hays and Ruby Sanborn.) Progress is observed in selective breeding of Rhode Island Reds for characters affecting high fecundity. Most of these characters are of rather complex genetic makeup. Early sexual maturity has been well established at a mean of about 190 days when birds are hatched in March and April. Intensity is still variable and the object is to attain a minimum of 3 eggs for winter clutch size. Winter pause has been reduced in duration, and the percentage of birds exhibiting pause has fallen as low as 27 percent. The percentage of broody birds and the degree of broodiness in broody birds have both gone to a low level. Persistency has improved so that the mean is not far below 365 days.

Beginning in 1929, comparisons have been made between the birds in this experiment and four strains from outside sources. From the standpoints of fecundity and of viability no outside strain has proved superior to our experimental strain. Crosses between the high fecundity line and these four strains did not produce superior birds.

Attention is also being given to fertility, hatchability, chick feathering, body weight, egg weight, plumage color, comb type, shank feathering, and inherited factors affecting mortality rate. Progress is being made without sacrificing desirable characters.

**A Study of Fertility Cycles in Males.** (F. A. Hays.) Records are being collected on the spermatogenesis of males of different ages through the fall, winter, and spring periods. Testicular tissue is being prepared for cytological study to develop some standard for comparing the reproductivity of different males. Particular attention is also being given to possible inherited factors affecting fertility in males. Preliminary data indicate notable differences in the histology of the testis as related to season.

**Physiological Relationships Between Molting Behavior and Fecundity Characters.** (F. A. Hays.) Bi-weekly records are still being made on the molting behavior of production-bred and exhibition-bred Rhode Island Red males and females. The third series of observations began July 25, 1940, and will be concluded December 26, 1940. The first breeding phase was begun during the spring of 1940 and data will be secured on the molting behavior of this first generation. The stocks available show wide variability in molting behavior, and several important relationships between molting behavior and fecundity are suggested.

**Miscellaneous Studies.** (F. A. Hays.) Several studies are being carried on under this heading. Rhode Island Reds are being studied for possible linkage relations between genes for shank feathering, genes for comb form, and genes for mottled ear lobe. Differences between Rhode Island Red plumage color and buff plumage color are being studied by hybridization. A method of separating sexes at hatching on the basis of down color is being studied in Rhode Island Reds. For auto-sexing, a type of gold barred bird is being developed.

**Manganese Requirement of Rhode Island Reds to Prevent Perosis.** (Marie S. Gutowska and Raymond T. Parkhurst.) To determine the threshold level of manganese necessary for the prevention of perosis in Rhode Island Reds, an experiment was conducted with four lots of chicks fed the standard perotic ration, supplemented with commercial ground calcites with and without manganese sulfate, so that the manganese levels

in the rations were 20, 34, 46, and 60 parts per million. Perosis developed in the two lots of chicks receiving the rations with 20 and 34 parts per million of manganese. It was concluded that perosis in Rhode Island Reds can be secured by feeding the perotic ration when its manganese level is not higher than 34 parts per million. The commercial calcites proved to be satisfactory sources of manganese for chicks in the prevention of perosis.

**Manganese Absorption in Fowls.** (Marie S. Gutowska, with E. M. Parrott and F. S. Slesinski of the Department of Chemistry cooperating.) By the use of the isolated intestinal loop technique, the total amount of manganese absorbed from solutions of  $\text{MnSO}_4 \cdot \text{H}_2\text{O}$  in 0.9 percent  $\text{NaCl}$  by Rhode Island Red cocks and hens was found to be proportional to the concentration of manganese in the loop. The percentage absorption of manganese from solutions containing 76, 40, and 10 p.p.m. averaged 35.8, 28.4, and 44 percent, respectively, in two hours. The amount of manganese absorbed per hour per kilogram of body weight in the fowl was relatively small compared with the amount of sugar or phosphorus reported absorbed by rats. Statistical analysis of results indicates that the difference in the absorption of manganese in males and females is not significant.

Manganese was still available for absorption when calcium ( $\text{Ca}(\text{NO}_3)_2$ ) and phosphorus ( $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$ ) or ( $\text{Na}_2$  glycerophosphate) were placed in the solution in the ratio of 3.91 to 1. An "in vitro" experiment, performed at  $41^\circ \text{C}$ ., the normal body temperature of the fowl, using the same systems, indicated that practically all the manganese was still present in the solution after the precipitate which formed was filtered off.

A relatively small amount of manganese diffuses from the isolated intestinal loop in dead birds.

**The Use of Corn Distillers Grains with Solubles in Poultry Rations.** (Raymond T. Parkhurst and F. L. Dickens, with C. R. Fellers of the Department of Horticultural Manufactures cooperating.) Corn distillers dried grains with solubles satisfactorily replaced the dried skimmilk, all the dried skimmilk and fish meal, or all the fish meal and part of the meat scraps in the 1939-1941 New England College Conference laying ration. These substitutions had no effect on egg production, egg weight, body weight, egg quality, or feed efficiency, but lessened hatchability. When the corn distillers dried grains with solubles were used at a 40 percent level in the Conference growing ration, a desirable flushing effect was obtained in young growing birds affected with coccidiosis.

When "complete" laying rations were supplemented with mash, it made no marked difference in egg production, egg weight, body weight, egg quality, feed efficiency, or hatchability whether the mash was moistened with water or supplemented with corn distillers semi-solid grains. Excellent, but approximately the same, results were obtained in the finishing of Rhode Island Red cockerels when the 1939-1941 New England Conference growing ration was supplemented with intermediate cracked corn or equal parts of the corn and corn distillers semi-solid grains with solubles. The birds made an average gain of 3 pounds between 12 and 20 weeks of age.

**Factors Affecting Growth, Pigmentation and Feathering in Broilers.** (R. T. Parkhurst and Waldon T. Hastings.) Preliminary studies in batteries indicated that good growth, pigmentation, and feathering can be

obtained when the 1939-1941 New England Conference starting mash is used as an all-mash broiler ration. The substitution of 1 percent of liver meal for 1 percent of meat scraps did not improve growth or shank color but gave much better feathering in the pullets. Satisfactory growth but lessened feed efficiency resulted when a partial substitution of fish meal for dried skim milk was made. When the fish meal ration was supplemented with 5 percent kelp meal, there was no improvement in feathering, shank color, hemoglobin, erythrocyte count, or taste; and feed efficiency was less.

## DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

**Poultry Disease Control Service.** (H. Van Roekel, K. L. Bullis, O. S. Flint, and M. K. Clarke.)

1. *Pullorum-Disease Eradication.* During the 1939-40 testing season there was a marked increase in the volume of testing over the previous year. Flocks were tested on 366 premises: 340 with chickens only, 6 with both chickens and turkeys, and 20 with turkeys only. A total of 689,377 tests was made: 680,663 for pullorum disease, 3,312 for fowl typhoid, and 5,479 for paratyphoid infection. The numbers of samples collected from chickens and fowl other than chickens were 676,611 and 12,776, respectively. Seventy-six reacting birds (66 chickens and 10 turkeys) were necropsied for 40 flock owners.

Testing service was rendered in 12 counties in which 673,222 chicken samples were tested for pullorum disease and only 0.51 percent were positive. No reactors were found among birds tested in 6 counties. All reactors were confined to 5 of the 17 breeds or varieties of fowl tested. Of the total chicken samples tested, 611,099 were from females (78,033 hens and 533,066 pullets) and 62,123 from males, among which 0.5 percent and 0.61 percent respectively were positive. The higher percentage of positive tests among males is attributed to the large number of male reactors in one large flock.

Tests were made of 346 chicken flocks representing 573,000 birds and 3,425 reactors were detected, 3,079 of which were found in 2 large flocks. "Breaks" were observed in 6 previously non-reacting flocks, in 4 of which the origin of infection could not be determined.

Pullorum-disease testing in turkeys has increased from 5,144 tests in 1938-39 to 12,771 in 1939-40. Three infected flocks were detected. Turkey growers are becoming more aware of the seriousness of this disease among turkeys.

Pullorum-disease eradication in Massachusetts is making satisfactory progress. During the past year 280 flocks were 100 percent tested with no reactors and represented 460,045 birds. With this volume of pullorum-free breeding stock, Massachusetts is in a position to replace its poultry population with pullorum-disease-free chicks.

During the past year this department has continued to cooperate with the Massachusetts Department of Agriculture by making available testing results which are used for official recognition and classification of pullorum-tested flocks.

2. *Diagnostic Service.* Personal delivery of specimens accounted for 405 of the 607 consignments including 3,026 specimens which are classified as

follows: 2,545 chickens; 307 turkeys; 55 pheasants; 29 canine feces; 15 ducks; 14 rabbits; 10 pigeons; 9 quail; 6 each of canary and mink; 5 each of canine, sheep, and swine; 3 each of bovine semen and bovine skin scrapings; 2 each of bovine feces, canine urine, and feline; 1 each of insects, ruffed grouse, and swine abscess.

The incidence of the more common and important disease conditions observed in chicks during the past five years is as follows:

	1935-36	1936-37	1937-38	1938-39	1939-40	Total
Avian tuberculosis .....		1	1	3	1	6
Coccidiosis .....	59	35	64	97	82	337
Enterohepatitis .....	6	2	7	6	7	28
Epidemic tremor .....	26	8	35	22	19	110
Fowl cholera .....	3	11	3	16	12	45
Fowl coryza .....		5	2	1		8
Fowl paralysis .....	39	37	45	77	47	245
Fowl pox .....	4	8	30	21	7	70
Fowl typhoid .....		4	2	11	4	21
Infectious bronchitis .....	19	40	31	48	57	195
Infectious laryngotracheitis .....	8	12	9	19	14	62
Internal parasites .....	21	23	21	41	26	132
Kidney disorders .....	25	17	15	37	21	115
Leukemia .....	11	7	3	6	3	30
Nutritional encephalomalacia .....	10	1	7	13	8	39
Paratyphoid .....	1	1	2	3	1	8
Perosis .....	10	4	2	4	3	23
Pullorum disease .....	44	39	46	49	32	210
Reproductive disorders .....	12	22	14	20	21	89
Rickets .....	9	8	6	19	19	61
Tumors .....	39	53	46	79	53	270
Gizzard erosions .....		1	15	14	15	45
Unknown disease .....	15	9	11	24	26	85
Unknown pullet disease .....	2	6	6	11	9	34

The 307 turkey specimens were received in 57 consignments. Coccidiosis 9, enterohepatitis 12, paratyphoid 14, and rickets 8, accounted for 51.8 percent of the diagnoses. Pullorum disease was noted in only one lot of poults and these were shipped in from out-of-state. That pullorum disease was present in some breeding flocks is indicated, however, by the isolation of *S. pullorum* from 6 of the 10 birds examined bacteriologically following the application of the agglutination test to 3 turkey flocks. A potentially important observation was made when *S. typhi-murium* was isolated from breeding birds over one year of age. Excessive mortality was reported in this flock during the breeding season. Poults from this flock were affected with paratyphoid infection. Fowl typhoid and fowl cholera were not identified in turkeys during the year. Swine erysipelas was identified in one case and ulcerative enteritis in 2 cases. A condition which has been reported to resemble perosis was observed in 2 flocks at about 16 weeks of age. Approximately 10 percent of the birds in one flock were affected.

Among pheasants a cecal infestation with a capillaria species was observed for the first time in this laboratory. We are indebted to members of the Zoological Division, Bureau of Animal Industry, United States



Department of Agriculture, who identified this parasite as *Capillaria caudinflata*.

3. *Flock Mortality Studies*. During the year, 277 morbid and dead birds from the Experimental Poultry Farm were necropsied. Unusual outbreaks of disease were not noted. The birds were hatched during the past five years. Among the birds received from those hatched in the spring of 1939, the largest number of males, 78.4 percent, was submitted from January to May 1940, inclusive; the largest number of females, 73.7 percent, from April to July, inclusive. In this group of birds cannibalism 17, and kidney disorders 14, accounted for 56.4 percent of the diagnoses among the males; and reproductive disorders 74, cannibalism 61, and kidney disorders 20, amounted to 76.3 percent of the diagnoses among the females.

4. *Avian Pox in Ruffed Grouse*. During October 1940, a grouse head was submitted by a person who had shot the bird during the hunting season. It was reported that the bird's flight was abnormal and that excrescences were observed on the eyelids and on the skin posterior to the upper beak. Laboratory examination revealed a suspicion of fowl pox infection. A saline emulsion prepared from the affected tissues and applied to scarified combs and wattles of susceptible chickens produced typical lesions of fowl pox within 8 days after inoculation. The inoculation of pox lesion material from the chickens into pheasants produced evidence of pox infection within 8 days. While pox has been reported in grouse previously by other investigators, this case is of interest to poultrymen and those concerned in upland game bird propagation. Furthermore, this case tends to substantiate the possible reservoir and hosts which may serve as a source of fowl pox infection to poultry, especially on range where direct contact between chickens, grouse, and pheasants is possible.

5. *Salmonella Types Isolated*. Salmonellosis is a disease entity which may occur in a variety of hosts and may be due to many species of organisms in the *Salmonella* group. The commonly designated paratyphoid organisms in the *Salmonella* group may cause severe losses. These paratyphoid infections express themselves most frequently among turkey poults, although their incidence among chickens is not to be underestimated.

During the past seven years, 68 strains were typed that had been isolated from specimens received at the laboratory. We are greatly indebted to Dr. Philip Edwards, Department of Animal Pathology, University of Kentucky, Lexington, Kentucky, who identified these strains as to type. The 68 cultures were isolated from the following types of specimens: Mature chickens 4; chicks 16; mature turkeys 3; poults 35; turkey egg 1; mature pigeons 3; and pheasant chicks, ducklings, canary, squab, wild mouse, and commercial rat virus each once. The incidence of the types is as follows: *S. typhi-murium* 47; *S. anatum* 5; *S. bareilly* 3; *S. kentucky* 2; *S. oranienburg* 2; *S. enteritidis* (var. *danyesz* and var. *jena*); *S. newport*; *S. derby*; *S. newington*; *S. new brunswick*; *S. minnesota*; *S. meleagridis*; and *S. thompson* each once.

During the past year, 17 strains were isolated and identified and all but one (*S. oranienburg*) were typed as *S. typhi-murium*. All of the 17 strains except one were isolated from mature and young turkeys and one turkey egg. Investigational work of a control nature is in progress.

6. *Viability of S. pullorum.* Studies to determine how long *S. pullorum* will remain alive in a dry piece of cloth stored at room temperature showed the organism to be alive after 7 years, 8 months, and 4 days. The last of the cloth prepared for this investigation was examined at the end of a period of 8 years, 3 months, and 8 days and no viable organisms were recovered.

7. *Transmission of Pullorum Disease by Cohabitation.* An attempt to transmit pullorum disease to non-reacting females gave negative results when non-reacting females and reacting males were confined in the same pen over a period of 9 months.

8. *Avian Encephalomyelitis.* Investigations during the past year have further substantiated that mature pheasants appear refractory to the infective agent when inoculated intracerebrally. Pheasant chicks inoculated intracerebrally failed to show definite symptoms, but brain suspensions prepared from these pheasants 76 days after the inoculation revealed that the infective agent was still present and capable of producing the disease in chicks. The virus was not demonstrable in the spleen after this period. Cohabitation of inoculated chicks with susceptible chicks produced positive transmission to the latter. The degree of spread however was slight. Fresh citrated blood obtained from affected chicks was capable of producing the disease in chicks when inoculated intracerebrally, intraperitoneally, and subcutaneously. This was likewise true of liver and spleen tissues inoculated by the intracerebral route. Chicks inoculated by intraperitoneal and subcutaneous routes readily contracted the disease. A group of 309 chicks (consisting of 2 different hatches) were hatched from eggs obtained from a commercial breeding flock whose progeny revealed one outbreak of the disease. The chicks were hatched and reared under control conditions. No evidence of the disease was noted. The infective agent used in some of the above-mentioned experiments is now in its 104th serial passage. Through repeated passage in chicks, the virus acquired a shorter incubation period, a shorter disease course, and a mortality rate of 100 percent.

9. *Farm Department Brucellosis Control and Eradication.* The laboratory cooperated in this work by testing 328 bovine blood samples with the standard tube agglutination method.

#### **Studies of Neoplastic and Neoplastic-like Diseases.** (Carl Olson, Jr.)

The transmissible lymphoid tumor of the chicken (described previously in Annual Reports for Years Ending November 30, 1938 and 1939) has now been carried through more than 60 serial passages in experimental chickens. The results for the first 30 passages in which birds received implants of the tumor either in subcutaneous or muscular tissue are summarized in the following table:

<i>Number Inoculated</i>	<i>Negative</i>	<i>Growth</i>
443	143 (32.3%)	300 (67.7%)

Regression of the growth occurred in 133 of the 300 chickens after it had reached a maximum state of development on an average of 13.6 days after inoculation. No pertinent pathology was observed in these birds at necropsy. The tumor had remained localized and actively growing in 116 of the chickens at the end of their experimental life, which averaged

about 23 days. In several instances the tumor had attained a size of more than 20 percent of the body weight of the host.

Metastasis of the tumor was observed in 51 cases. Metastatic foci of the tumor were found in most of the visceral organs, although they were more commonly noted in the heart, proventriculus, and adrenal glands. In 21 of the cases only a single visceral organ was affected with tumor. One case of diffuse metastasis in the liver, spleen, and bone marrow was noted in the twenty-sixth serial passage of the tumor. Such cases have been encountered frequently in chickens inoculated with material after the forty-fifth passage of the tumor, and the birds die from 9 to 15 days after inoculation. Such a reaction represents a new character of the tumor that has developed due to serial passage.

Fowl paralysis developed in some birds after implants of the tumor (about 3 percent of those inoculated in the first 30 serial passages). There were eight cases (about 5 percent) of fowl paralysis among 151 uninoculated control chickens. The average age when the first symptoms were noted was approximately 72 days in the case of inoculated and 67 days in the case of uninoculated chickens. Therefore, there seems to be no significant association of fowl paralysis with the transmissible lymphoid neoplasm.

Progress has been made on the study and classification of more than 600 cases of spontaneous neoplastic disease in chickens derived from various sources.

Studies of the antigenic composition of blood cells of chickens, discussed in a previous Annual Report (for Year Ending November 30, 1939) have been continued. The results to date may be briefly summarized as follows:

The mating of chickens whose blood cell types were Class I produced progeny with blood cells of the same class. The mating of chickens whose blood cells were of Class II produced progeny with blood cells of the same class. The mating of chickens whose blood cells were Class III produced progeny with blood cells of Classes I, II, and III in the ratio of approximately 1, 1, and 2, respectively. The mating of chickens in which one sex had Class I blood cells and the other sex had Class II blood cells produced progeny with Class III blood cells. These results lead to the tentative conclusion that the genotype of Class I cells is a combination of two dominant genes (AA); Class II cells, of two recessive genes (aa); and Class III cells, of dominant and recessive genes (Aa).

## WALTHAM FIELD STATION

(Waltham, Mass.)

Ray M. Koon, in Charge.

The members of the research staff of the Waltham Field Station are assigned to the unit by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Reports of these departments give results of investigations conducted at this station.

**Evaluation Gardens.** The collection of hardy perennials numbering about 2000 species and varieties has proved to be of definite value to commercial nurserymen and the general public.

Promising new perennials received in the spring of 1940, although not yet tested over winter, include:

*Astilbe Fanal* (*A. arendsi* var. *Fanal*) bears well-shaped spikes of a clear wine red; a new color in this genus.

*Phlox paniculata* var. *Eva Foerster*, a dwarf form and vigorous grower, is deserving of particular notice. Its blossoms carry a fine strong pink tone after the salmon tinge of the newly opened florets has disappeared.

*Heliopsis patula* (Le Moine strain) repeats the fine characteristics of *H. scabra* var. *incomparabilis* with its sturdy, yellow, 3-inch, semi-double late summer blooms. The plants were too young to indicate whether or not this variety extends the bloom season beyond that of *H. scabra* var. *incomparabilis*.

*Oenothera glauca* var. *Illumination* and *O. fruticosa* var. *Yellow River* definitely promise extension of the blooming season for this species.

*Clematis*: A varietal form of the fragrant tube *Clematis* (*C. heracleae folia* var. *dauidiana*), available this year under the name *Azurea*, gave a prolific bloom and greater fragrance than other varietal forms.

*Peonies*: Among the single Japanese peonies (whose blossoms, being less heavy than double forms, recover from heavy rainstorms rapidly) the following are outstanding: *Ama-no-sode*, *Currant Red*, *Isani Gidzu*, *Dog Rose*, *Edward VII*, and *Tokio*.

In order to acquaint the public with the best of the azaleas, plants of the following species and varieties were set out in the spring: *R. arborescens calendulaceum*, *canescens*, *dauricum* var. *mucronulatum*, *japonicum*, *nudiflorum*, *obtusum* var. *kaempferi*, *roseum*, *schlippenbachii*, *yedoense* var. *poukleanense*, *vaseyi*, and *viscosum*. This list, approved by growers of eastern Massachusetts, represents azaleas most successfully grown in this region.

**Field Day.** The twenty-second annual Field Day on August 7, 1940, attracted over 1300, the largest number of visitors yet recorded. The attendance, in spite of threatening weather early in the day, shows the keen interest of the growers in the work at the Field Station. Eight entries in the new Summer Pascal celery contest demonstrated how widely this variety has been planted in this, its first year in commercial production. Because of the increased interest in machinery, it was necessary to enlarge the area devoted to exhibits.

**Soil Testing Service.** To most individuals soil tests are of value only when an interpretation of the findings can be made by some qualified person. Such an interpretation must invariably be accompanied by a recommendation for treatment. A total of 6050 samples was tested in 1940, compared with 2704 in 1937.

## PUBLICATIONS

### Bulletins

- 336 Apple Cider and Cider Products. By J. A. Clague and C. R. Fellers. 36 pp. July 1940. (A reprint of a bulletin issued first in November 1936.)

Greater care in the application of approved known methods in the production and preservation of apple cider and cider products should make for an enlarged demand for these popular by-products of the fruit industry. This bulletin gives the results of investigations in this field.



- 369 Annual Report for the Fiscal Year Ending November 30, 1939. 104 pp. February 1940.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

- 370 Transmissible Fowl Leukosis. A Review of the Literature. By Carl Olson, Jr. 48 pp. April 1940.

There is considerable uncertainty as to the relationship between the various diseases grouped under the term "fowl leukoses," due partly to the varying results obtained by different investigators and also to the indiscriminate use of terms. This review of the literature was prepared in the hope that it might help to clear up this confusion and thus lead to a better understanding of these diseases—a necessary preliminary to the development of control measures.

- 371 Cranberry Growing in Massachusetts. By Henry J. Franklin 44 pp. June 1940.

Directions for growing cranberries, from the selection and preparation of the land to the harvesting and marketing of the berries, with photographs illustrating all important points.

- 372 The McIntosh Drop. By Lawrence Southwick. 19 pp. May 1940.

Among the factors considered, methods of culture which produced the most vigorous growth and heaviest yields also had a tendency to increase drop. Apples with many seeds tended to hang longer than those with fewer seeds. Experiments with several chemical sprays were successful in delaying or preventing drop, but further study is needed to determine whether this method is practical for general orchard use.

- 373 Foods and Public Health. By James E. Fuller. 16 pp. May 1940.

The aim of this bulletin is to present fundamental information about food-borne diseases in a manner comprehensive yet simple. Only those food-borne diseases are discussed that are important in the every-day life of the average community. Diseases that occur only rarely or not at all in our country are not included.

- 374 Minerals in Nutrition. 40 pp. August 1940.

Several departments in the Experiment Station have been co-operating in studies designed to add to our knowledge of minerals in foods, particularly the relation of minerals to certain disabling diseases such as arthritis and hardening of the arteries. The following papers are included:

- I. Total nutrients and minerals in human and cattle foods.
- II. The absorption by food plants of certain chemical elements important in human physiology and nutrition.
- III. Possible relationship of Vitamin C and arthritis.
- IV. The effect of kelp and mineral supplements on atherosclerosis in rabbits induced by feeding cholesterol.
- V. Effect of added iodine on the enzymes of milk and on other enzymes.
- VI. Added iodine in milk and fecal bacteria.
- VII. Iodine and bacterial counts in milk.

- 375 Biological Control of Mealybugs in Greenhouses. By W. D. Whitcomb. 22 pp. July 1940.

Laboratory studies demonstrated the possibility of biological control of mealybugs by the use of the imported ladybird beetle, *Cryptolaemus montrouzieri*, Muls., and indicated some of the conditions necessary for success. Tests were then made in greenhouses to determine whether and under what conditions this method of control is practical in commercial practice.

- 376 The Culture and Forcing of Easter Lilies. By Harold E. White. 20 pp. August 1940.

The culture of Easter lilies for potted plants and cut flowers is an important source of income to Massachusetts florists. The cultural conditions necessary for success with this crop are described and discussed, with special reference to the effect of controlled rooting temperatures on the growth of the lilies.

- 377 Inheritance of Broodiness in Rhode Island Reds. By F. A. Hays. 11 pp. October 1940.

Breeding tests extending over ten years have led to the following conclusions. Broodiness as measured by the number of broody periods in the first laying year is inherited. Broodiness depends in inheritance on two complementary dominant genes, neither of which appears to be sex-linked. Deferred broodiness greatly retards progress in breeding to eliminate the broody trait, and the complete elimination of broodiness appears to be very unlikely.

#### Control Bulletins

- 103 Twentieth Annual Report on Eradication of Pullorum Disease in Massachusetts. By the Poultry Disease Control Laboratory. 13 pp. June 1940.
- 104 Inspection of Commercial Feedstuffs. By Philip H. Smith. 72 pp. October 1940.
- 105 Inspection of Commercial Fertilizers. By Philip H. Smith and J. W. Kuzmeski. 49 pp. October 1940.
- 106 Inspection of Agricultural Lime Products. By Philip H. Smith and J. W. Kuzmeski. 11 pp. October 1940.
- 107 Seed Inspection. By F. A. McLaughlin. 104 pp. November 1940.

#### Meteorological Bulletins

- 613-624, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By C. I. Gunness. 4 pp. each.

#### Reports of Investigations in Journals

##### Numbered Contributions

- 335 Vitamin B<sub>1</sub> and vitamin B<sub>2</sub> (G) content of vegetables as influenced by quick-freezing and canning. By C. R. Fellers, W. B. Esselen, Jr., and G. A. Fitzgerald. Food Res. 5 (5):495-502. 1940.
- 340 Onion juice and bacterial growth. By James E. Fuller and Ernest E. Higgins. Food Res. 5 (5):503-507. 1940.
- 342 Coliform bacteria and streptococci in swimming pool water. By Ralph L. France and James E. Fuller. Amer. Jour. Pub. Health 30 (9):1059-1062. 1940.
- 343 Observations on the development of certain cell-wall constituents of forage plants. By Emmett Bennett. Plant Physiol. 15:327-334. 1940.
- 345 Effect of benzoated brine dips on keeping quality of fish fillets. By C. R. Fellers and E. W. Harvey. Food Res. 5 (1):1-12. 1940.
- 351 Pectins and the texture of cooked potatoes. By Monroe E. Freeman and W. S. Ritchie. Food Res. 5(2):167-175. 1940.
- 352 Action of acetic acid on food spoilage microorganisms. By A. S. Levine and C. R. Fellers. Jour. Bact. 39 (5):499-514. 1940.
- 353 Canned Atlantic crab meat—A new American food. By Carl R. Fellers and Sterling G. Harris. Indus. and Engin. Chem. 32:592. 1940.

- 354 Pullorum disease control and eradication. By Henry Van Roekel. *Vet. Med.* 35 (1): 1940.
- 356 The grape plume moth. By W. D. Whitcomb and W. E. Tomlinson, Jr. *Jour. Econ. Ent.* 33 (2):372-374. 1940.
- 357 Report on Zinc. By E. B. Holland and W. S. Ritchie. *Jour. Assoc. Off. Agr. Chem.* 23 (2):302-303. 1940.
- 358 Injury to trees from sulfur dioxide fumes of electric refrigerators. By Malcolm A. McKenzie and Linus H. Jones. *Science* 91 (2358):239-240. 1940.
- 359 Spur nitrogen and pre-harvest McIntosh drop. By Lawrence Southwick. *Amer. Soc. Hort. Sci. Proc.* 37 (1939):435-437. 1940.
- 360 The depth of planting asparagus and its effect on stand, yield and position of the crown. By Robert E. Young. *Amer. Soc. Hort. Sci. Proc.* 37 (1939):783-784. 1940.
- 361 Inhibiting effect of acetic acid upon microorganisms in the presence of sodium chloride and sucrose. By A. S. Levine and C. R. Fellers. *Jour. Bact.* 40(2):255-269. 1940.
- 362 Effect of exercise on growth and cataract development of rats fed galactose. By Helen S. Mitchell and Gladys M. Cook. *Proc. Soc. Expt. Biol. and Med.* 43:85-86. 1940.
- 363 Phomopsis gardeniae in relation to gardenia culture. By Malcolm A. McKenzie, Linus H. Jones, and Constantine J. Gilgut. *The Plant Disease Reporter* 24 (3):58-62. 1940. (Mimeographed)
- 364 Breeding small flocks of domestic fowl for high fecundity. By F. A. Hays. *Poultry Sci.* 19 (6):380-384. 1940.
- 366 Syrup of cranberry, a new pharmaceutical vehicle. By J. A. Lubitz, C. R. Fellers, and J. A. Clague. *Jour. Amer. Pharm. Assoc., Sci. Ed.*, 29 (7):323-325. 1940.
- 367 Study practical gardenia canker control as disease increases. By M. A. McKenzie, L. H. Jones, and C. J. Gilgut. *The Florists' Review*, March 28, 1940.
- 368 Color markings in Rhode Island Red chicks. By F. A. Hays. *Jour. Agr. Res.* 61 (1):69-74. 1940.
- 72 Propagation of white pine by cuttings. By William L. Doran, Robert P. Holdsworth, Arnold D. Rhodes. *Jour. Forestry* 38 (10):817. 1940.
- 73 Canned dessert apples. By A. A. McCormack, C. R. Fellers, and W. A. MacLinn. *Fruit Prod. Jour.* 20 (1):5-6, 25. 1940.
- 74 Soil as rooting medium for cuttings. By William L. Doran. *Amer. Nurseryman* 72 (5):7-8. 1940.
- 78 Grass silage on Massachusetts dairy farms. By Charles R. Creek. 17 pages, mimeographed. August 1940.
- 82 Vitamin C in packaged foods purchased in retail markets. By K. R. Newman and C. R. Fellers. *Jour. Amer. Dietet. Assoc.* 16 (7):695-696. 1940.

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- 'ut the minerals on the land—not in the manger. By J. G. Archibald. *Shorthorn World* 25 (19):88. December 25, 1940.
- ortality in street tree planting. By Malcolm A. McKenzie. *Proc. Mass. Tree Wardens' Ann. Meeting*, February 7-8, 1940.
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- Diseases of tree leaves and fruits; Diseases of woody parts of trees; Diseases of underground parts of trees. By Malcolm A. McKenzie. A Handbook of Information for Tree Wardens and City Foresters (published by Mass. Tree Wardens' Assn.) pt. IV:81-84. 1940.
- The Dutch elm disease situation as it concerns Massachusetts. By A. Vincent Osmun. Transcriptions of Certain Papers presented at the Seventh Annual Five-Day Short Course for Tree Wardens and Foresters:43-45, M. S. C., March 30, 1940.
- Sulfur dioxide gas damages foliage. Science News Letter 37 (2):184. March 23, 1940.
- How can the small milk producer meet pasteurization requirements? By J. H. Frandsen. Sixth Ann. Year Book, Mass. Milk Inspectors' Assoc. 1940.
- Quality goat's milk and how it is produced. By J. H. Frandsen. Dairy Goat Jour. March, 1940.
- Sanitary aspects of packaging milk and milk products. By M. J. Mack et al. Amer. Jour. Pub. Health Yearbook Supplement to Vol. 30, No. 2, February 1940.
- The use of corn syrup solids in ice cream and ices. By L. R. Glazier and M. J. Mack. Proc. 40th Ann. Conv. Internatl. Assoc. Ice Cream Mfrs., October 1940.
- Suggested standards for chocolate milk drinks. By W. S. Mueller. Milk Plant Monthly, March 1940.
- Orchard insect pests in 1939. By W. D. Whitcomb and A. I. Bourne. Mass. Fruit Growers' Assoc. Ann. Rpt. 1940:18-22.
- Apple pests and their control. By A. I. Bourne, O. C. Boyd, O. C. Roberts, and W. D. Whitcomb. M. S. C. Extension Leaflet 189. 56 pp. October 1940.
- Controlling the grape plume moth. By Wm. E. Tomlinson, Jr. Horticulture, April 15, 1940, page 4, New England Section.
- Results of recent Massachusetts spraying experiments. By A. I. Bourne. Jour. N. H. Hort. Soc. 4 (1):20-27. 1940.
- A report of a study of container costs in soda fountains. A clean service for every customer every time. By Rollin H. Barrett, Carl R. Fellers and Julius Novick. The Sanitarian 2 (12):1-13. 1940.
- Facts you should know about foreign substance in food. By Carl R. Fellers. The Internatl. Steward 36 (8):8-9, 12 and 16. 1940. Hotel and Restaurant 8 (6): 14-15, 57.
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- Food Poisoning. By C. R. Fellers. Old Farmer's Almanac No. 195. 66. 1941.
- Celery—Boston Style. By Robert E. Young. Better Crops with Plant Food, August-September 1940.
- Asters, the best of the Michaelmas daisies. By Ray M. Koon. House and Garden, September 1940, p. 28.



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MASSACHUSETTS;  
AGRICULTURAL EXPERIMENT STATION, *Amherst*

BULLETIN NO. 388

FEBRUARY, 1942

## Annual Report

For the Fiscal Year Ending November 30, 1941

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

MASSACHUSETTS STATE COLLEGE  
AMHERST, MASS.

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# MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

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	Term Expires
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CASEY, WILLIAM, <i>Commissioner of Agriculture</i>	
MONAHAN, WILLIAM C., Framingham	1943
McNAMARA, MRS. ELIZABETH L., Cambridge	1944
HUBBARD, CLIFFORD C., Norton	1946
WHITMORE, PHILIP F., Sunderland	1943

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GASKILL, EDWIN F., Assistant to the Director

O'DONNELL, MARGARET H., Technical Assistant

HAWLEY, ROBERT D., Treasurer

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CHURCH, LUCIA G., Secretary

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- PARKINSON, LEONARD R., Station Service
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- SANBORN, RUBY, Poultry Husbandry
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- WERTZ, ANNE W., Home Economics
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- †WILSON, HAROLD A., Horticulture
- YEGIAN, HRANT M., Agronomy
- YORGA, FRANK, Horticultural Manufactures
- ZATYRKA, IRENE E., Pomology

\*In charge

†At East Wareham

‡At Waltham

§With U. S. D. A.

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# ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION -- 1941

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## DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

**Competitive Factors Influencing the Supply of Market Milk and Cream in Massachusetts.** (A. A. Brown and Mabelle Booth.) The manuscript on the Production and Price of Milk in the Springfield-Holyoke-Chicopee Milkshed has reached the final stages of editing. This report is the third in a series pertaining to the shed and represents a tentative appraisal of the forces affecting the crigin of the milk supply. The principal one appears to be the system of pricing f. o. b. the market. In secondary markets this type of pricing underlies the inefficiencies in transportation which in turn are probably a cause of the non-economic pattern of milksheds. A reasonable correction would seem to be a shift to pricing f. o. b. the farm.

**An Analysis of Selected Merchandising Practices in the Fruit and Vegetable Industry.** (A. A. Brown and Mabelle Booth.) A record of the operations on the Boston Regional Produce Market in 1941 has been secured in addition to that of 1940. Cursory examination indicates that conditions were similar in both seasons. Most of the farmers using the market are small operators. The majority of them used it only a few times during the season. A few of them, however, are large operators who supplied the bulk of the produce.

The financial situation of the market corporation is its chief obstacle to growth. Because of this, the fixed plant remains undeveloped. Until a greater degree of permanency is assured, improvements such as store and storage facilities are not probable. Lack of these facilities keeps wholesalers and jobbers away from the market; shipped-in produce is not generally available; buyers go to other markets where complete supplies may be had.

**Crop and Livestock Enterprise Relationships to the Farm Business in Massachusetts.** (C. R. Creek.)

*Vegetable Growing in Bristol County, Massachusetts, in 1940.* Records of the farm business were obtained on 22 specialized vegetable farms and on 10 livestock-vegetable farms for 1940. Since the season was more nearly normal than in 1939 in regard to yields and prices for vegetable crops, the 22 specialized farms showed a net cash return over cash operating expenses ranging from a gain of \$8,022 to a loss of \$270 per farm.

Average returns for the livestock-vegetable farms were lower than for the specialized vegetable farms in 1940. The livestock enterprises showed a return over costs but the important crops—potatoes, sweet corn, and cabbage—were relatively unprofitable in 1940. On many farms income from the livestock enterprises prevented a loss in net returns.

Recommendations for improved practices and management were made on the basis of results obtained from this study. Many small farms have incurred unnecessary losses in recent years chiefly because of poor management and lack of adjustment to changing conditions in vegetable growing and marketing.

Results of this study were published in Mimeograph FM8 in October 1941, under the title, "Vegetable Growing in Bristol County, Massachusetts, in 1940."



*Two Years of Vegetable Growing in Bristol County, Massachusetts—1939 and 1940.* The farm records for 1939 and 1940 on the specialized vegetable farms were studied to determine the reasons for the increased returns in the latter year. Net cash return averaged \$1777 per farm in 1940 compared to a loss of \$4 in 1939. Records were obtained for 20 of these 22 farms in both years.

Higher yields and higher prices for four important crops were chiefly responsible for the higher returns. The acres of crops per farm were practically equal, cash farm expenses increased only 20 percent over 1939, but sales of produce increased 60 percent. Yields and prices increased greatly in 1940 over 1939 for iceberg lettuce, cucumbers, green beans, and early tomatoes. Yields were maintained for sweet corn, late tomatoes, cabbage, and potatoes, but prices were lower particularly for cabbage and tomatoes.

Net cash returns for the livestock-vegetable farms were slightly lower in 1940, with an average of \$1399 compared to \$1453 in 1939. Number of cows and acres of crops for sale were the same in both years, but the average size of poultry flocks increased slightly. Unprofitable crops such as potatoes, cabbage, and sweet corn were responsible for the lower returns in 1940.

Budget analyses were made for a small and a large specialized vegetable farm and for a livestock-vegetable farm to show expenses, income, yields, and prices for the two years. Diversification of the farm business on the latter farm was discussed in relation to the more uniform returns in both years. Preliminary recommendations for improving the farm business were made on the basis of this two-year study.

Results of this study were published in Mimeograph FM9 in October 1941 entitled, "Two Years of Vegetable Growing in Bristol County, Massachusetts—1939 and 1940."

*Diversification of the Farm Business.* In response to a request from the Subcommittee on Diversification, of the Essex County Rural Policy (Land Use Planning) Committee, a summary was made of farm records from previous studies to show the effect of various types of diversified farm businesses on farm organization and net returns.

Diversity by the processing and distribution of farm products was shown to be very profitable in the case of retail dairy farms from the 1936-37 study of dairy farm management. With the same number of cows per herd, but receiving 7 cents per quart extra for milk, the retail farms had net cash returns four times greater than the specialized wholesale dairy farms. In the case of poultry farms for 1937 this method of diversification was not so profitable. The retail farms had larger flocks, and more eggs were sold at a price 6.5 cents per dozen higher; but net cash returns and farm income were almost equal to those on the specialized wholesale poultry farms. Cash operating expenses were too high and the spread from wholesale to retail price was too narrow for extra profitable operation of these retail farms.

Wholesale dairy farms with a fruit or vegetable enterprise were generally more profitable than the specialized dairy farms. Because of unfavorable price relationships in 1936, the combination of dairy and poultry enterprises was less profitable.

Another method of diversification on poultry farms was the selling of hatching eggs or baby chicks in addition to market eggs, broilers, and fowl. The more intensive of these hatchery farms with 30 percent of cash receipts from the sale of baby chicks and pullets showed the highest net returns of any group in the 1937 study. The wholesale egg farms with some hatching egg and baby chick business were the next most profitable, although the price received for market eggs was lowest. Largest size of laying flock, highest egg production per hen,

and a balanced farm business in the growing of flock replacements were contributing factors to high farm returns.

A balanced or diversified farm business will tend to produce a net return year after year in contrast to high returns and losses on specialized farms. In general a diversified farm business is to be desired, although not all farms of this type are profitable.

**Labor Saving Methods and Practices on Massachusetts Farms.** (C. R. Creek.)

*Harvesting and Packing Iceberg Lettuce.* The results of this study on vegetable farms were published in Mimeograph FM5, February 1941. Diagrams of packing shed equipment and layout were included as well as descriptions and discussions of various methods of harvesting and packing.

*Harvesting and Packing Tomatoes.* This study was published as Mimeograph FM6 in March 1941 and contained descriptions of methods and practices in harvesting and packing tomatoes in different types of containers for various markets. Diagrams of packing equipment such as conveyor belts, tables, and trays are included, plus time data on the efficiency of different methods.

*Harvesting and Packing Celery.* This study was published as Mimeograph FM7 in May 1941 and supplements a previous description and analysis of packing operations on farms producing celery. Information on equipment and practices in the field work of harvesting celery and a diagram of the packing shed layout for the handling of celery and carrots was included.

**Rural Credit in Massachusetts.** (A. H. Lindsey and Sargent Russell.) During the year, 273 survey records of 1940 farm operations were taken covering 10 towns in 5 counties of the State. Analysis has not been completed but preliminary conclusions are as follows: (1) The best incomes can be obtained by farmers when they combine non-farm work, such as retailing of their produce, selling grain or machinery, or working off the farm, with their farm operations; (2) In 1940 poultry paid better than dairy, and dairy better than vegetable; (3) Farmers on the whole know where to borrow money at reasonable rates; (4) Farmers borrow as little as possible and although many could use more capital they have restricted their borrowing, not because the money isn't available, nor because their credit standing isn't satisfactory, but because difficulties of repayment outweigh the advantage of increased income due to the investment; (5) In spite of what appears to many as a chronic low income for farm operators, farmers do continue to accumulate an estate in Massachusetts; (6) Tenancy (100 percent rented farms) is low, part ownership and part rent occurs on more than a third of the farms; (7) About two-thirds of the farms have mortgages, and on about one out of every three mortgaged farms the mortgage amounts to over half of what the farmer estimates his farm is worth; (8) The ability of the operator is probably the most important variable in farm operation. The better operators achieve greater success primarily because they have: (a) Good size of business, (b) efficient use of labor, (c) above average crop and livestock production, and (d) good balanced use of all resources (diversity).

**Land Tenure in Massachusetts.** (A. H. Lindsey and Edward Collins.) The United States Census does not give a complete picture of land tenure in Massachusetts. The 6 percent of tenancy reported by the Census refers to leased whole farms. Our survey shows that another 31 percent of farm owners rent land in addition to their own. This may be properly termed "field renting."

Six percent of the farms available for lease is not sufficient to provide opportunity for prospective owners to use farm tenancy as a "rung" in the agricultural ladder in achieving ownership. The most popular way of earning an equity for the purchase price of a farm was to work as an industrial laborer.

The practice of field renting enables Massachusetts farmers to enlarge their farm business and thus to increase their family income. A loss of these areas would reduce individual farm business to an uneconomic size. Rented fields which are under cultivation usually are satisfactorily maintained but practices are not equal to those on owned land. Conservation practices on rented hay and pasture land were much poorer than on owned land. Eighty-five percent of rented fields were used for hay or pasture. Nine out of ten of the field-renting leases were oral as compared to two out of three where whole farms were rented. Of the part owners who were renting fields, 97 percent received no supervision or direction from the land owners regarding the use of the land.

## DEPARTMENT OF AGRONOMY

Walter S. Eisenmenger in Charge

### Tobacco Projects. (Walter S. Eisenmenger and Karol J. Kucinski.)

*Brown Root-Rot of Tobacco.* Experience has shown that the presence of high amounts of lignin in the crop preceding tobacco is generally associated with the presence of brown root-rot of tobacco. It is well known that the lignin content of plants increases from the seedling stage to maturity. With this in mind, twelve crops—tobacco, artichoke, corn, oats, buckwheat, barley, rape, millet, rye, wheat, sudan grass, and sorghum—were all sown at the same time, and one third of the area of each was plowed under at three different stages of maturity of the plants. Tobacco was planted on all areas the following year.

When those plants having a relatively high lignin content, such as sudan grass, sorghum, corn, millet, rye, barley, and oats, were plowed under at maturity, the tobacco grown on these plots the following year had lower yields and lower crop indexes than tobacco grown following the same plants plowed under before they reached maturity. With those plants low in lignin, such as tobacco, artichoke, and rape, the stage of maturity of the plant did not produce the same effects as in the case of the high-lignin plants.

*The Effect of Additions of Plant Tissue to Tobacco Land.* A corn crop preceding tobacco is injurious to the following tobacco crop. In order to find out whether this injurious effect is due to the presence of abnormal amounts of fibrous tissue or to the removal of nutrients consequent on the growth of the corn, corn stover, in pieces about one inch long and in amounts comparable to that usually grown on a given area, was applied to soil which was to be planted to tobacco. A decrease in both yield and quality of the tobacco crop resulted.

These results are no doubt traceable to the high lignin content of the corn stover applied, because it is generally known that organic matter of this sort has a tendency to lower the available nitrogen in the soil to which it is applied.

*Tobacco Experiments with Application to Soil of Commercial Organic Materials.* It has been suggested that the source of organic compounds might possibly determine the yield and quality of the subsequent tobacco crop. Sugar, carbon (charcoal), dry skim milk, and starch were the materials selected for comparison. They were applied at the rate of two tons to the acre. A fifth plot, to which nothing was added, was included as a check.

There was little difference in the action of these different materials. The applications of charcoal or carbon gave the highest yield, as was anticipated from the appearance of the crop in the field; but the quality of this tobacco lowered the crop index value.



**The Absorption by Food Plants of Chemical Elements Important in Human Nutrition.** (Walter S. Eisenmenger and Karol J. Kucinski.) Some plants have the ability to take up certain chemical elements from the soil in amounts greater than normal, depending both on the ion involved and on the species of plant.

In previous trials, an increase in the amount of magnesium, sodium, potassium, and chlorine added to the soil resulted in increased intake by the plant. In the present experiments, sodium, potassium, and magnesium were compared with calcium; and phosphate and sulfate were compared with chlorine, bromine, and iodine, in this respect.

The increased intake of potassium, sodium, or magnesium, due to the addition of these ions to the soil, was more pronounced than the increase in calcium resulting from the addition of similar chemical quantities of calcium. Also, the percentage increase of chlorine, bromine, and iodine in the plants when these elements were added to the soil was higher than that of sulfur or phosphorus when similar chemical quantities of these anions were added.

This indicates that those elements which are more abundant in sea water than in soil water are the ones which can be introduced into plant tissue with little difficulty. In some respects it would seem that our land plants have not fully adjusted themselves to a land environment.

**The Intake by Plants of Elements Applied to the Soil in Pairs Compared to the Intake of the Same Elements Applied Singly.** (Walter S. Eisenmenger and Karol J. Kucinski.) Cabbage, lettuce, beans, and celery were grown on plots to which various elements had been added, in pairs, in quantities known to be excessive but not toxic. Chemicals compounds, used in all possible combinations of two, supplied calcium, potassium, and sodium at the rate of 250 parts per million of soil and lithium at the rate of 100 parts per million. The exceeding toxicity of lithium to plants necessitated application at the lower rate and at a considerable time before planting. The calcium intake by cabbage, celery, and lettuce was decreased when either sodium or potassium salts were applied with the calcium. The potassium intake was increased in this combination. The lithium intake was decreased when potassium was applied with the lithium. The potassium intake was decreased somewhat when plants were grown on a combination of potassium and sodium.

**Magnesium Requirements of Plants.** (Walter S. Eisenmenger and Karol J. Kucinski.) Various species of plants have been grown on a plot known to be deficient in magnesium. There is little evidence to indicate a reason for the varied reactions of different plants to the scarcity of magnesium ions in the soil. Different members of the same family react differently. Sudan grass shows no symptoms, nor does timothy; but regular field corn becomes chlorotic, and hybrid sweet corn scarcely sets any seed. Pumpkin vines show distinct chlorosis; watermelons do so only at maturity.

There is evidence now that plants may suffer from the lack of this element, yet may not show any chlorosis or lack of chlorophyll formation. Strawberry plants do not become chlorotic, yet new runners are formed more abundantly and the strawberry row is wider where magnesium is applied, while the row becomes narrow where no magnesium is applied. The very common garden weed, purslane (*Portulaca oleracea*), called by the farmer "pussley," forms a thick mat where magnesium was applied and ceases to grow, except in rare instances, where the soil is deficient in magnesium. If a plant can be found, it is not chlorotic. Apple leaves from trees on magnesium-deficient soils are not chlorotic, but areas of the leaves become dark brown and eventually die, much like the leaves from a potash-deficient plant.



On areas of the plot where lime was applied, the sugar content of the fruits was increased in some instances. This was true of blueberries and grapes, but not of watermelons.

**The Absorption and Excretion of Potassium and Calcium by the Roots of Barley in Different Solution Media and Changes in pH.** (Walter S. Eisenmenger and George Wenzel.) Determinations were made of the absorption and excretion of potassium and calcium, by (barley) plants and excised root systems of barley, from and into one-salt solutions of different concentrations, and into distilled water. A study of the changes in hydrogen-ion concentration of the solutions was also included. The salts used were acid potassium phosphate ( $\text{KH}_2\text{PO}_4$ ), and calcium nitrate ( $\text{Ca}(\text{NO}_3)_2$ ). The length of the experimental period was 72 hours in all tests.

The intensity of absorption and excretion increased with the length of the experimental period. In general the absorption increased rapidly after the first 24 hours, while the excretion increased slowly throughout.

The reaction of the media was never stable in the presence of live root systems. The pH values increased during the daylight hours and decreased somewhat during the night. The continual change of pH values was, undoubtedly, tied up with absorption and excretion phenomena of electrolytes, but to state that the degree of change was absolutely proportional to the rates of absorption and excretion would imply the exclusion of buffer action and other controlling factors.

The proportion of absorbable ions absorbed during a given period decreased as the concentration of these ions in the solution decreased. In this way plants can adapt themselves, to a considerable extent, to solutions of low concentration.

For the first two days potassium was more firmly held by the roots than calcium, after which calcium was excreted in larger amounts, but no considerable excretion of either was observed. The excretion of ions into salt solutions was greater than into distilled water.

An equivalent absorption and excretion of calcium and potassium did not take place, except for extremely short periods.

The results with excised roots show that roots alone are not capable of a uniform absorption of ions.

Attention is called to the fact that energy exchanges are involved in the processes of absorption and excretion. Permeability and osmosis alone are inadequate to explain these phenomena in the living plant.

**Sunflowers and Their Possibilities.** (Karol J. Kucinski and Walter S. Eisenmenger.) This year's growing season was an exceptionally good one for sunflowers, which grew to maturity and formed very large seed heads. Seedlings of one seed per hill every 18 inches in 36-inch rows produced a yield of over two tons per acre of well-formed large seeds. This yield is much larger than that obtained in past years, indicating that a good corn-growing season is also a good sunflower season. At the current wholesale market price of sunflower seed the value per acre is about \$225 to \$250. This crop would seem to have great possibilities if grown commercially, even on some of our lands which have a high per acre valuation. Since it is somewhat difficult during this present national emergency to import from abroad as much sunflower seed as is necessary, it might be feasible for some of our farmers to grow the crop commercially.

The oil obtained from sunflower seed is very high in content of vitamins A and D, but it is used in this country primarily as a drying oil in paints. In eastern continental Europe the peasant population has always eaten the seed. It has been thought by some scientists that this seemingly habit-forming practice of eating the sunflower seed is an instinctive effort on the part of the individual to supplement his usual deficient diet with the high nutritive contents of the seed.

**Soil Conservation Research Projects.** (Karol J. Kucinski and Walter S. Eisenmenger.)

*A Study of the Physical and Chemical Properties of Wind-Blown Soils.* Only certain types of soil in Massachusetts are normally affected by wind. The object of this study is to determine whether there is any relation between the physical-chemical properties of these soils and their susceptibility to wind erosion. Soils from wind-eroded and non-wind-eroded areas have been examined for their physical and chemical properties, such as mineral and organic colloidal fractions, plasticity, hygroscopicity, mechanical analysis, heat of wetting, heat of conductivity, capacity of absorption, and such other soil properties as are deemed of value. The effect of chemical and physical changes in soil, brought about by the addition of fertilizer, lime, or organic matter, has been studied by means of a small wind tunnel. Preliminary tests were sufficiently satisfactory to warrant the construction of a larger wind tunnel with certain modifications which should make it more suitable for the purpose.

*Experimentation with Topsoil Removal.* (In collaboration with Arthur B. Beaumont.) In order to measure the effects of loss of topsoil on yield, the topsoil (to plow depth) was totally removed from one plot with a bulldozer, while an adjacent plot was left undisturbed as a check. Spring wheat and white sweet clover were grown on fertilized and unfertilized portions of these two areas.

The increases in yield due to fertilization were significant on both areas. However, the decreases in yield due to topsoil removal are alarming. With spring wheat, the decrease in yield where the topsoil had been removed was 63 percent on the fertilized plot and 91 percent on the unfertilized. With white sweet clover, the results were even more extreme: where topsoil had been removed, there was 81 percent decrease in yield on the fertilized plot and total crop failure (100 percent decrease) on the unfertilized plot. These results show the value of the topsoil and the loss to the farmer if his topsoil were totally removed at one time. Under normal conditions only a small part of the topsoil is removed each year by erosion, and the farmer is not so conscious of his loss.

**Nature of Soil Erosion in Massachusetts.** (Arthur B. Beaumont and Karol J. Kucinski.) Accelerated water erosion of Massachusetts soils is widespread but of slight to moderate intensity. However, cultivation of steep slopes through a long period has caused the removal of the entire original topsoil in places and its accumulation at the foot of slopes within comparatively short distances from the point of origin. The character of the soils is important as affecting the nature of the erosion. Being of medium texture and low in colloidal matter, they have low suspensibility in water. A preliminary examination of important soil types gave dispersion ratios ranging from 9.3 to 15.3 with most of them below 11.0. Because of the low suspensibility of the soils, they are deposited as soon as the velocity of the water carrying them is slightly lessened. Streams in this section rarely run muddy, and then only at times of high flood.

The pictures on page 53 illustrate (1) the difference in the suspensibility in water of Merrimac fine sandy loam, an important soil of the Connecticut Valley, and Memphis silt loam, an important soil of the Mississippi Valley; and (2) the depth of topsoil accumulated by sheet erosion of a cultivated Massachusetts slope.

**Experimentation with Historical "Soil-Test Plots."** (Walter S. Eisenmenger and Karol J. Kucinski.) Fifty-one years ago a series of plots was inaugurated to study the effects on the soil and crops of a long-time fixed-fertilizer program. The purpose was to find out the fertilizer needs of the soil tested. Results of these tests published about twenty years ago showed "that fertilizer needs are

determined as much by the farming system followed and the kind of crops grown as they are by the type of soil being farmed."

Since that time these plots have been used for experiments with fruit trees, following the original system of fertilization. The fruit trees have now been removed, leaving a field with limed and unlimed portions of plots which for the past fifty years have had applications of nitrogen, potash, and phosphoric acid, singly and in various combinations. The check plots have been left unfertilized during the entire period. Preliminary observations during the past year have shown that the fertility level of all the plots is much higher on the limed than on the unlimed portions. The unlimed portions of the check plots showed crop failures and indications of nutrient deficiencies.

It is the intention to continue this study with the view of observing more carefully the various nutrient deficiencies singly and in combination as they appear in the various crops to be grown on this area.

**Potato Variety Trials.** (Ralph W. Donaldson, Walter S. Eisenmenger, and Karol J. Kucinski.) Based on yields of marketable size, the ranking of potato varieties grown in plots at the college during the season of 1941 were Sequoia, Earlane No. 2, Green Mountain, Russet Rural, Katahdin, Houma, Irish Cobbler, Red Warba, Sebago, and Chippewa.

**Soil Nitrates Lower pH Reactions.** (Ralph W. Donaldson, Walter S. Eisenmenger, and Hrant M. Yegian.) A marked depression of pH reactions which occurred in potted soil as nitrates formed and accumulated was mentioned last year in reporting "the effect of fineness of limestone on soil reaction."

Results of a similar trial in progress now, covering a 12-month period, substantiate the previous findings. In this later trial oats were successively grown on a duplicate series of limed and unlimed soil, in an attempt to remove by plant assimilation the nitrates which develop. Both the cropped and the uncropped soil of any given treatment first exhibited similar reactions except for slight variations dependent upon ammonia development. When nitrates developed, however, the uncropped soils dropped about .7 of a pH below corresponding cropped soils, depending upon the relative amounts of nitrates present. This situation prevailed within limed and unlimed treatments.

Since the product of organic matter decomposition is ultimately nitrates, which under some conditions may accumulate in the soil solution and cause a lowered pH reading, this factor may be important when recommending lime for sensitive crops like potatoes and tobacco. A field sample which shows high nitrates after harvest may give a pH reading about .5 lower than a sample taken during the active growing period of the crop when nitrates are being absorbed. For example, it is conceivable that a potato soil during the active growing period of the crop may show low nitrates in the soil solution and test pH 5.5; yet when tested after harvest, with nitrate accumulated, it may test pH 5.0, for which a light lime application might (wrongly) be suggested. Whether such differences occur under field conditions at least merits consideration.

**Borax Trials on Several Crops.** (Ralph W. Donaldson, Walter S. Eisenmenger, and W. G. Colby.) Applications of borax to established stands of alfalfa have been continued on more than 20 farms in the State. Both spring and fall applications at 25 and 50 pound rates have been compared, with no evidence at all of injury from the higher rates. In fields where alfalfa "yellows" appeared this season, borax applied prior to this spring effected marked control. This was evident also in single treatments of 25 pounds per acre applied in the fall of 1939, indicating, thus far at least, a two-season carry-over from treatment. The effect of borax applied in the spring was less marked in controlling yellows on the crop which



followed. A marked deficiency of normal rainfall occurred following application of the borax. Evidence that borax may contribute to longevity of alfalfa is indicated by plant response to two seasons' applications compared with the check in two fields.

Borax was broadcast at 25 pound rates in strips on a variety of crops growing on six market garden farms. The treatments were made early in May, without regard to planting time and seedling stage. In no case did growers observe any injurious effects from the borax.

Fertilizer containing 20 pounds of borax per ton was drilled in bands at a ton rate on an acre of Cobbler potatoes planted by D. Wilson Smith, Scituate. There were no symptoms of plant injury which could be attributed to the borax.

**Oat Variety Tests.** (W. G. Colby.) Eleven named varieties of oats, including several of the recently developed, smut-resistant strains, were grown at Amherst during the past season. The results are reported in Control Bulletin 111, Seed Inspection (pages 92-93), where these named varieties are compared with a number of lots of commercial seeds.

**The Effect of Arsenious, Arsenic, and Antimony Oxides on Soil and Plant Growth.** (Walter S. Eisenmenger and Hrant M. Yegian.) Pot culture studies under greenhouse conditions on the effect of arsenious, arsenic, and antimony oxides on Merrimac fine sandy loam and subsequent crop growth are being continued. Six successive crops, barley and buckwheat alternating, were grown in the same soil in pots during 1939 and 1941. On June 11, 1941, tobacco seedlings were transplanted to these treated pots. The tobacco was harvested November 14, 1941.

Arsenious oxide, 500 p.p.m., retarded the growth of tobacco and prevented blossoming; while 500 p.p.m. with organic matter produced a fully mature, normal plant. Concentrations of 1000 p.p.m. or over of arsenious oxide were very toxic even in the presence of organic matter.

Arsenic oxide, 750 p.p.m. reduced the growth of tobacco and prevented blossoming; 750 p.p.m. with organic matter, however, produced a fully mature, normal plant. Concentrations of 1000 p.p.m. or over of arsenic oxide, with or without organic matter, were very toxic to tobacco.

The arsenic content of a few of the tobacco leaves, stems, and seeds was determined<sup>1</sup> by the micro Gutzeit method, modified according to C. C. Cassil. The results of these analyses may be summarized as follows:

1. At the low concentration of arsenic (240 p.p.m. As) in the soil, the stems and leaves contained 3 to 6 p.p.m. As, while none was detected in the seed.
2. At the higher concentration of arsenic (480 p.p.m. As) in the soil, the stem and leaves contained 12 to 18 p.p.m. As, and no seeds were produced.
3. Indications are that the concentration of arsenic in the tobacco leaves exceeds that in the stems. The number of determinations, however, was not great enough to warrant definite conclusions at this time.

The tobacco plants in pots containing 1500 and 2000 p.p.m. arsenious oxide made no growth during the five-month period. At the end of five months these plants were transplanted to  $\text{As}_2\text{O}_3$  free soil. While these plants have resumed growth, it is not a normal but a rosette growth. This may be due either to the age of the transplants, short daylight conditions, presence of arsenic in the plant, or to a combination of all these factors.

The antimony oxide treatment did not affect the growth of tobacco at any concentration (250 to 2000 p.p.m. antimony oxide).

<sup>1</sup>By John W. Kuzmeski, Senior Chemist, Control Laboratory of the Massachusetts Agricultural Experiment Station.



**Hybrid Field Corn.** (Hrant M. Yegian.) There is a definite need for an early-maturing hybrid field corn for the higher plateau regions of Worcester County and the western counties of Massachusetts. Accordingly, 64 strains of hybrid seed corn were planted for trial during the past season. A few of these strains, which matured in 90 to 100 days, will be tested next season in Athol, Massachusetts, against the local-grown varieties in that region. Last season 180 inbred lines and single crosses were crossed with Wis. (CC4×CC8). Most of these crosses will be tested for early maturity and yield this coming season at the College Farm.

**Onion Breeding.** (Hrant M. Yegian.) Hybrids between *Allium fistulosum* (type Nebuka) and *A. cepa* (type Ebenezer) were secured in the spring of 1940. All the flowers of two umbels from Nebuka plants were emasculated twice daily for about two weeks and dusted daily with pollen grain from Ebenezer. Of the 230 plants from one of the umbels 80 percent were hybrid between the two species. Only 10 percent of the plants were hybrid from the second umbel. Although there were no apparent morphological differences between the hybrids and the Nebuka at the seedling stage, the hybrid plants could be recognized in the field by their vigor, the semi-circular leaves growing close together, and the color of the bulbs. Some of these hybrids will be treated with calchicine in an effort to secure tetraploids.

Sufficient seed for testing has been produced from a strain of Ebenezer selection that will mature bulbs about two weeks earlier than the valley-grown varieties. Final field tests will be made before the strain is recommended to the growers.

Data from a two-year preliminary experiment show that there is no significant difference between the yield of set onions grown in double rows and those grown in single rows 14 inches apart. Planting sets in double rows 4 inches apart and placing the double rows 24 inches apart would greatly facilitate the use of power cultivators.

**Influence of Soil Fertility on Productiveness of Pasture Species.** (Walter S. Eisenmenger and Hrant M. Yegian.) It has long been observed that there is a close relationship between the fertility of the soil and the botanical composition of the vegetation growing upon it. It would be of great interest, therefore, to know whether there are specific levels of soil fertility which are required by different species of pasture plants in order that they may thrive and maintain themselves over an extended period.

The data covering one year of preliminary field plot experiment on the effect of four levels of soil fertility on thirteen species of grasses in pure stand warrant the following general statements:

1. That all the species responded to increase in soil fertility.
2. That the species which produced poorly at a low fertility level gave much greater percentage increases in yield at higher fertility levels. Meadow foxtail, for example, produced an average of 0.19 pounds of dry hay in the plots that had no fertilizer, and 0.54 pounds (184 percent increase) in the plots treated at the rate of 1600 pounds of 5-8-7 per acre. On the other hand, meadow fescue, which averaged 0.48 pounds of dry hay in no-treatment plots, produced 0.76 pounds (58 percent increase) at the highest fertility level (1600 pounds 5-8-7 per acre). However, in each of the four levels of soil fertility, the species which produced greater total dry weight in no-treatment plots outyielded the species which produced poorly in no-treatment plots.
3. That the better-producing species were those well adapted to the climate. Apparently temperature is one of the important factors influencing yield. Perennial rye grass and fowl bluegrass did well in cool weather, but during the heat of summer they dried out; whereas meadow fescue, reed canary grass, and orchard grass maintained comparatively well-sustained growth throughout the season.

**Experiments at Amherst with Pasture Seeding Mixtures.** (W. G. Colby.) For the purpose of studying different strains of grasses and legumes under actual grazing conditions, three series of plots were laid out in 1940, on land which had been brought to a high state of fertility through the liberal use of lime, manure, and commercial fertilizer. Two series of 19 plots each were seeded August 23, 1940, and a third series of 13 plots was seeded April 18, 1941. The same mixtures were included in each series as far as possible. In several instances, limited seed supplies prevented the use of certain mixtures in more than one or two of the three series.

The object of the experiment was to compare a system of hay-pasture management with pasturing alone and to test summer seeding of pasture mixtures against spring seeding. During 1941, Series I was subjected to four periods of intensive grazing by a small herd of dairy cows: in May, July, August, and October. Series II was first cut for hay before being subjected to three periods of grazing, which coincided with the last three grazing periods of Series I. The spring-seeded series (III) was grazed only lightly at the same time as Series II. The following observations and results deserve mention:

1. Brome grass and meadow fescue (Svalof's early) showed the most promise as being desirable companion grasses for Ladino Clover. The cutting of an early hay crop followed by several periods of intensive grazing appeared to be the most desirable way of utilizing these grasses.

2. Hay types of orchard grass (Scandia and Commercial) as well as the less vigorous pasture types (S26 and S143) did not combine well with Ladino Clover. The orchard grass, irrespective of how it was managed, tended to crowd out the clover even during the first season. This occurred partly because orchard grass grows vigorously throughout the season and partly because it produces tussocks or bunches. Animals grazing on Ladino Clover mixtures with this grass tended to graze the clover growing between the bunches of orchard grass much more closely than they did the clumps of grass, even though the orchard grass was kept in a young, active vegetative growth stage at all times. As a result of preferential grazing, the stand of orchard grass continually improved and the stand of clover deteriorated.

These observations may explain why, in Massachusetts, orchard grass in Ladino Clover seeding mixtures invariably crowds out Ladino Clover, completely, after three or four years and results in a pure stand of orchard grass.

The most promising mixtures using orchard grass were those which included alfalfa and which were cut for hay before being grazed. For this purpose, the later-maturing pasture strains (S26 and S143) were much superior to the hay strains. There is a real need for a hay strain which will mature from a week to ten days later than do any strains now available.

3. The hay-pasture system of management rather than pasture alone appears to have excellent possibilities as a way of utilizing a number of these early maturing grasses (brome, meadow fescue, orchard) not only in producing a good early hay crop but also in providing excellent feed for midsummer grazing. In these experiments, about two tons of dry hay were cut to the acre in the middle of June, followed roughly by three quarters of a ton of dry herbage as grazing the latter part of July, about the same quantity again late in August, and another half ton early in October.

4. Observations on palatability indicated that timothy ranked first among the grasses, followed in order by brome grass, meadow fescue, red top, orchard grass, and tall fescue (Alta strain). Alfalfa, red clover, and alsike, although quite palatable as young plants, became less palatable than Ladino Clover as the plants became older and developed woody stems. The woody, unpalatable stem growth of alfalfa is a serious handicap to the use of this plant for grazing purposes.

5. A good stand of alfalfa was obtained in all of the hay-pasture mixtures (Series II), but only weak stands were obtained when an early period of grazing took the place of a crop of hay (Series I). Apparently alfalfa must be allowed to become well established before grazing is begun.

6. Bird's-foot trefoil, under the condition of these experiments, showed no promise whatsoever.

## COOPERATIVE TOBACCO INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture in Cooperation with the Massachusetts Agricultural Experiment Station

C. V. Kightlinger, U. S. D. A., in Charge

**Black Root-Rot.** (C. V. Kightlinger.) Black root-rot is one of the most common diseases of tobacco, and probably the most important disease of Havana Seed and shade tobaccos in the Connecticut Valley at the present time. The disease is recognized generally as being highly important on the basis of losses caused by moderate to heavy infections which are easily recognized as black root-rot. Its importance is not so generally recognized when losses are caused by light to moderate infections, largely because of the tendency to accept the low yields as a matter of course instead of attributing them to specific causes, and also because black root-rot is not always easily recognized in cases of light infections, even though they may be sufficient to cause low yields. It is reasonably certain that black root-rot causes light to moderate damage to tobacco in the Connecticut Valley much more generally than is commonly recognized at the present time.

An effective and convenient method of controlling the disease would mean much to the tobacco growing industry. The disease and the conditions under which it occurs are of such a nature, however, as to make resistance to the disease the most feasible control method after soil conditions favorable to the disease have become established; and the use of resistant strains, even before soil conditions favorable to the development of the disease have become established, would permit greater range in fertilizing practices, particularly in the use of lime, than is otherwise advisable, which would often promote the production of better tobacco. Consequently the attempt to develop strains of Havana Seed which are more resistant to black root-rot and more acceptable in type, quality, yield, and certain other characteristics, is being continued. The importance of the disease and the prospects of eventual success seem to justify the continuation of the project.

The plan as it is being worked at the present time is two-fold. In the first place, selections of Havana 211, which is itself moderately to highly resistant to black root-rot under Connecticut Valley conditions but which is not entirely acceptable in type, quality, and certain habits of growth, have been made to improve the strain in type and date of maturity. In the second place, new strains have been produced by crossing strains of Havana Seed which are resistant to black root-rot but not entirely acceptable in type and quality, with strains of common Havana Seed which are not resistant to black root-rot but are acceptable in type and quality, in the hope of obtaining new strains which embody the desirable features of both parents.

Tests of the selections of Havana 211 and of the crosses have been made, and are being made, in the greenhouse and in the field, to determine their value. Some of the selections of Havana 211 show improvements over the original strain in certain characteristics, but little if any improvement in resistance to



black root-rot or in habits of growth. Earlier maturity, which was greatly desired, was not obtained in any of the selections of Havana 211. Some of the selections from the crosses possess sufficient resistance to yield well under black root-rot conditions in the Connecticut Valley, and also show distinct improvements in important characteristics of type and habits of growth, including earlier maturity. Some of these selections are as early maturing as the strains of common Havana Seed which were used in making the crosses. They seem, also, to be superior to either parent in some important characteristics such as shape of leaf and size of veins. These particular strains deserve more testing to determine their full resistance to black root-rot and also to determine the permanency of the improvements in type and habits of growth which have been manifested so far. It seems reasonably certain, however, that definite progress has been made.

**Brown Root-Rot.** (C. V. Kightlinger.) Brown root-rot causes some damage to tobacco in the Connecticut Valley at the present time and probably would cause much more damage if it were not that the circumstances under which the disease ordinarily occurs are now known and are avoided in large measure in present practices of growing tobacco in the Connecticut Valley. The practices of not rotating tobacco with crops known to produce soil conditions favorable to the development of brown root-rot and of growing tobacco continuously after tobacco for as long a time as may be possible are applicable in the control of the disease where the acreage of tobacco is being maintained or reduced somewhat, as has been the case in the Connecticut Valley during the last few years. This method of control, however, is restrictive and is not always convenient to follow even under present circumstances, but the rather dilligent application of the practice has reduced the prevalence and severity of the disease so that it has been of minor importance economically in the Connecticut Valley during the last several years.

Brown root-rot may become more prevalent and injurious in the Connecticut Valley in case of an increase in acreage of tobacco, because of the necessity of using additional land which, on account of previous cropping, may be in a condition favorable to the development of the disease. If this occurs, it will contravene the only measure for the control of brown root-rot of tobacco which is generally recognized at the present time as being applicable to field use. Therefore, a measure which would control brown root-rot of tobacco satisfactorily under varied circumstances and which would be convenient to use on considerable acreages would mean much to the growing of tobacco in the Connecticut Valley in the event that the acreage is increased. Such a measure would be useful also under present circumstances, especially if it would permit rotation of tobacco with other crops in general.

With this situation in mind, experiments were begun in 1939 to obtain further information on the relationship of soil fertility conditions to the development and to the control of brown root-rot of tobacco. One purpose in particular is to study the effect of certain soil treatments on the fertility levels of the soil and to study the effect of different degrees of fertility of the soil on the occurrence of brown root-rot of tobacco following the crops used in the experiment. It is desired especially to learn whether brown root-rot will develop in tobacco which is grown continuously after tobacco under low fertility conditions of the soil. And finally, in case brown root-rot of tobacco develops as a result of these experiments, another purpose is to study means of hastening recovery.

The arrangement and procedure of the experiments designed to determine whether low fertility of the soil may promote the development of brown root-rot of tobacco, consists of four sets of six one-twentieth acre plots in which tobacco, corn, millet, rye, clover, and timothy-red top mixture are grown in the same



manner, except for differences in the use of fertilizers. On two sets of these plots an application of 10-10-10 fertilizer has been made each spring at the rate of 3000 pounds per acre to the plots planted to tobacco, and 2000 pounds per acre to the plots planted to the other crops, in a manner suitable for fertilizing each particular crop. On two other sets of plots no fertilizer has been used, except nitrate of soda which has been applied to all plots alike at the rate of 400 to 500 pounds per acre, to aid in reducing the fertility level of the soil in these plots. The crops were all harvested and removed from the plots each year according to regular farming practices. In an additional experiment on a quarter-acre plot considerably removed from the other experiments, tobacco is being grown continuously after tobacco without any fertilizer at all being used. No results can be reported at this time.

The control phase of the experiment is contingent on the outcome of the other phase; consequently the details of the control phase are not given here.

**Soil Treatments for Tobacco Seedbeds.** (C. V. Kightlinger.) Damping-off diseases and weeds are troublesome in tobacco seedbeds in the Connecticut Valley. Consequently treatments for their control are important.

Experimental work to test the effectiveness of spring and fall treatments of seedbed soil by steaming and with formaldehyde, and of fall treatments with chlorpicrin and with calcium cyanamid, was begun in 1940 and continued in 1941. The seedbed used for these tests had been prepared especially for the purpose by inoculating uniformly and heavily with damping-off organisms during the spring of 1940. Evidence that the seedbed was abundantly infested with disease organisms was shown by the damping-off of tobacco seedlings grown during the spring and even into late summer of 1940. Care was taken also to make certain that seeds of the more common weeds of tobacco seedbeds were disseminated evenly throughout the soil.

The steaming was done by the pan method at a steam pressure of about 100 pounds applied for 20 minutes, with the pan kept in place for another 20 minutes after steaming had been discontinued. The spring treatment with formaldehyde consisted of a standard solution made of 1 gallon of formalin to 50 gallons of water, applied at the rate of one-half gallon of solution to 1 square foot of soil surface. The fall treatments were steaming, as described above; formaldehyde solution of standard concentration and double the standard concentration, applied in both cases at the rate of one-half gallon of solution to 1 square foot of soil surface; chlorpicrin, applied at the rate of 2 cubic centimeters per square foot of soil surface, and also at double this rate of application, to a depth of about 4 inches into the soil, by means of commercial applicator commonly used for the purpose; calcium cyanamid, applied at the rate of one-half pound per square yard of soil surface, and also at double this rate. In both cases, the calcium cyanamid was worked into the soil thoroughly, three-fourths of the total amount to a depth of 4 to 5 inches and one-fourth to a depth of about 1 inch. The soil treated with calcium cyanamid and chlorpicrin was of proper moisture content for effective treatment at the time and was moistened daily for several days thereafter. The soil temperature at the time formaldehyde, calcium cyanamid, and chlorpicrin were applied in the fall was 67° F., and changed little for a considerable time following the treatments.

No damping-off of tobacco seedlings occurred during the season of 1941, even in the untreated plots of the seedbed, in spite of the fact that tobacco was seeded at double the usual rate and the bed was watered thoroughly every day, and sometimes oftener, to promote damping-off. The unusually warm, dry weather which occurred during the spring of 1941 was sufficient, apparently, to prevent damping-off in spite of the effort that was made to promote its development.

Consequently the comparative value of the treatments for controlling damping-off could not be determined.

The treatments all gave some control of weeds. There were wide differences, however, in the different treatments and also in different replications of the same treatment, except in the case of steaming, which gave consistently good control in all replications of either the fall or the spring treatments. Some replications of the treatments with calcium cyanamid, chlorpicrin, and double-strength formaldehyde solution applied in the fall gave fairly good control of weeds; but these were largely offset by unsatisfactory control in other replications of the same treatments. Steaming was the only treatment that gave entirely satisfactory control of weeds.

The experiment is being repeated.

## DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

**A Study of the Mineral Elements of Cow's Milk.** (J. G. Archibald and C. H. Parsons.) During the winter of 1940-41 the possibility of increasing the manganese content of milk by feeding supplemental manganese was investigated. Eight cows in the college herd were divided into two groups of four each, and fed manganous sulfate (1 ounce daily) by the double reversal system. Monthly sampling and analyses of the milk of the individual cows from November through April, showed that, regardless of group or individual, the feeding of the manganese supplement definitely increased the manganese content of the milk. On the average the amount of manganese in the milk of cows receiving the supplement was just about double that in the milk from cows not receiving it. (46.1 gammas of Mn per liter of milk as contrasted with 23.5 gammas per liter). Advance announcement of this finding has been published in *Milk Plant Monthly*, Vol. 30, No. 9, September, 1941.

**Investigation of the Merits of Legume and Grass Silage for Massachusetts Agriculture.** (J. G. Archibald and C. H. Parsons.) As a result of comparative trials extending over three years with molasses and phosphoric acid as silage preservatives, this station has discontinued the use of phosphoric acid as a preservative. The reasons for this are:

1. Molasses silage has been definitely more palatable to milking cows than phosphoric acid silage.

2. Molasses costs somewhat less, even when the much smaller amount of phosphoric acid required is taken into consideration.

Work this past year with grass silage has centered chiefly around its effect on milk flavor in contrast with the effect of corn silage. Part of the herd was fed grass silage and another part corn silage, and the schedule was reversed at mid-season. Individual milk samples from all cows milking at the time have been taken for a period of three days in each month from November through April and judged for flavor. There are some discrepancies among the results, and the differences are not very marked, but in general the grass silage has produced milk with a higher flavor score and with less incidence and persistence of the common off-flavors. Individual off-flavors most reduced when grass silage was fed were malt, bitter, rancid, and oxidized in the order named.

**A Study of Urea as a Partial Substitute for Protein in the Rations of Dairy Cows.** (J. G. Archibald.) This project has been actively conducted throughout the year. Results are available from two years of double reversal trials with eight

cows and from a full lactation period of continuous feeding of urea to eight other cows in comparison with a similar group continuously fed the regular herd ration. Final conclusions cannot be drawn until the second year of continuous feeding of urea to the eight cows, just referred to, has been completed, and until at least a year's results are available from a group of cows more recently put onto a control ration containing no urea. This last phase of the investigation has been included in order to check more closely the adequacy of basal protein levels in the ration. All things considered, to date the urea ration seems to be producing results similar to those obtained on the regular ration.

## DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

**Nitrification in Soils Containing Plant Residues of High Lignin Content.** (James E. Fuller, cooperating with the Agronomy Department.) During the growing season of 1940 thirteen plots were under observation. During the growing season of 1939 one of these plots had remained fallow, and each of the remaining twelve had been planted with a forage crop. There were no duplicates. Then, in 1940, the whole area was planted with tobacco, after the plant residues of the preceding crop had been plowed under. Soil samples were taken in the spring of 1941, in mid-season, and again after the harvest. The soils were studied for their ability to nitrify their own nitrogen, added dried blood, and added ammonium sulfate, respectively. The results of the nitrification studies were compared with the quantity and quality of tobacco produced on the plots in 1940. There was some evidence, in the dried-blood study, that plots giving less active nitrification gave poorer quantity and quality of tobacco.

The study was repeated on a second field in 1941. The set-up was replicated six times, giving 78 plots instead of the 13 studied in 1940. Results of 1941 have not been analyzed sufficiently to permit any statement at the present time.

**Comparative Study of Certain Media Employed for Fecal-Flora Studies.**<sup>1</sup> (James E. Fuller and Irwin Fried.) Much of the investigational work on fecal bacteriology, in connection with nutritional studies, is based upon determining the ratio of bacteria of the lactobacillus group to those of the coliform group, because a predominance of lactobacilli is considered desirable for intestinal health. It is desirable, also, to differentiate the members of the coliform group present in order to make a useful interpretation of results.

The present study compared certain media commonly employed to enumerate coliform bacteria. Results were as follows: litmus-lactose agar, bromocresol-purple agar, and lactose agar with Andrade's indicator were not selective for the coliform group of bacteria, and gave no differentiation within the group. Endo's agar and E. M. B. (eosin-methylene blue) agar gave distinctive colonies of the group and good differentiation, but both produced substantially fewer colonies than lactose agar when plates were made with these three media from pure cultures of bacteria of the coliform group. This indicates that both Endo's and E. M. B. media give low counts of coliform bacteria when they are used in fecal-flora studies. Certain combinations of non-coliform bacteria produced reactions on these media that could be confused with those of the coliform group. MacConkey's bile-salt agar inhibited growth of bacteria of the group to a greater extent than did either Endo's or E. M. B. media, and did not give satisfactory differentiation within the group.

**The Bacteriology of Chocolate Syrups, Cocoa Powders, and Chocolate Milk.** (James E. Fuller and R. W. Swanson, in cooperation with W. S. Mueller of the Department of Dairy Industry.) Bacteria counts showed wide variation in the numbers of bacteria in the different syrups and powders. Most of the bacteria identified were aerobic sporulating bacteria of the *Bacillus subtilis* group. No Gram-negative bacteria of intestinal type were found, which would indicate that the syrups and powders were free from intestinal contamination. Bacteria of this type inoculated into solutions of the syrups and powders survived only a few days.

Growth of bacteria was not as rapid, nor were the counts as large, in milk with syrups or powders added as in the same milk supply without the addition. Thus, it appears that the syrups and powders had some inhibitory effect on bacterial growth. Further studies indicated that the tannins present in the syrups and powders were responsible for the inhibition. Oxalic acid and theobromine, in concentrations found in chocolate or cocoa, had no apparent effect on bacterial growth. Molds and yeasts appeared to be more active than bacteria in causing spoilage of chocolate milk.

**Studies of Methods for Determining the Sanitary Quality of Drinking Utensils.** (Ralph L. France, W. E. Cassidy, and James E. Fuller.) Work on this project has been completed, with the following results: (1) A swabbing method is the best for recovering bacteria from the lips of a glass. (2) A wet swab is more efficient than a dry or moist swab. (3) The most satisfactory suspending fluid is one having the following composition: 2.5 cc. of 0.04 M  $\text{MgSO}_4$ , 2.5 cc. of 0.01 M  $\text{CaCl}_2$ , 0.5 cc. of 0.001 M  $\text{FeCl}_3$ , and 1.25 cc. of Butterfield's buffered phosphate solution made up to 100 cc. with distilled water. (4) The most satisfactory plating medium was one with the following substances: Neopeptone, 10 grams; yeast extract, 5 grams; dextrose, 0.5 gram; NaCl, 5 grams; and agar, 15 grams. The reaction of this medium is adjusted to pH 7.5. (5) Inoculation of a swab, or 1 cc. of a 1/10 dilution of washings from the swab, into dextrose broth frequently revealed the presence of mouth streptococci. This test has considerable sanitary significance when used in conjunction with the count. The addition of potassium tellurite to the dextrose broth failed to eliminate interfering organisms.

**The Effectiveness of Certain Detergents and Procedures Employed for the Cleansing of Eating and Drinking Utensils.** (Ralph L. France.) Field studies have been made of the methods employed in the cleansing and sanitization of eating and drinking utensils in public establishments throughout this area. Bacteriological examinations indicate that these methods are not satisfactory. Work is being continued on this project.

**Laboratory Service.** (Ralph L. France.) Following is a list of the types and numbers of examinations made during the past year.

Milk (bacteria counts).....	895
Ice cream (bacteria counts).....	153
Water.....	124
Eating and drinking utensils.....	120
Miscellaneous.....	106
Butter fat:	71
Solids:	22
Mastitis:	12
Burlap:	1
Total.....	1,398



## DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

**Diseases of Trees in Massachusetts.** (M. A. McKenzie and A. Vincent Osmun.)

*The Dutch Elm Disease Problem.* For several years in the cooperative program for the study of the Dutch elm disease in Massachusetts, intensive effort has been concentrated in Berkshire County as new stations for the causal fungus, *Ceratostomella ulmi* (Schwarz) Buisman, were reported in nearby New York and Connecticut. During recent years, the circulation of numerous false reports that the disease was present in Massachusetts, and even the publication of photographs of trees removed because they were affected by the disease have sometimes confused and alarmed the public. At least a part of the confusion has resulted from the failure to distinguish between the fungus which causes the Dutch elm disease and the principal carrier insect, *Scolytus multistriatus* Marsh., which is a bark beetle infesting certain areas of Massachusetts, notably southern Berkshire County and the region east of Worcester County.

The spread of the disease into Massachusetts was delayed for several years by the eradication of diseased trees in the adjoining states, although early in 1941 it was pointed out<sup>1</sup> that elms in southwestern Massachusetts were in immediate danger from the encroachment of the disease on Berkshire County from New York on the west and Connecticut on the south. However, in September 1941 the first Massachusetts elm in which the presence of the disease could be officially established, was eradicated—a young tree about 20 feet in height growing on private property in the town of Alford. Typical symptoms of foliage wilting and streaking of the woody parts were present. The *Scolytus* beetle was not found in the tree but has been observed in the town. In the vicinity of the diseased tree and elsewhere throughout Massachusetts, hundreds of other trees showing symptoms macroscopically indistinguishable from those of the Dutch elm disease were checked in field and laboratory studies during the past year, but no additional trees with the disease have been discovered. The work of the organized project of this Station in collecting and studying specimens from suspected trees has been supplemented by other public and private groups and by individuals, including the Massachusetts Department of Agriculture, the United States Department of Agriculture, the Massachusetts Forest and Park Association, town and city tree wardens, employees of other municipal and state departments, arboriculturists, public utilities, and private citizens.

The most constructive procedure in attempting to check the spread of the disease is the removal of all elm material in such a condition as to be attractive to carrier beetles. The quantity of such material present in any location may be related to a number of factors, as in southern Berkshire County where drouth injury and repeated attacks of leaf-chewing insects have seriously weakened many elms in such a manner as to make them suitable for infestation by beetles; and the destruction of this material will doubtless prove of inestimable value in limiting the population of carrier beetles of the Dutch elm disease fungus.

*Other Tree Problems.* Sixty-nine diseases of thirty-four species of trees, including eleven diseases of elm were identified from more than 500 specimens and inquiries received during the year. The *Cephalosporium* wilt of elm was reported from 21 municipalities in which no previous cases of the disease were reported,

<sup>1</sup>McKenzie, Malcolm A. The Dutch elm disease problem in Massachusetts. Published in "Progress Report including Transcriptions of Certain Papers presented at the Eighth Annual Five-Day Short Course for Tree Wardens and Other Workers with Trees," M. S. C., March 28, 1941.

making a total of 173 cities and towns in which the disease has been found in Massachusetts. Also, a fungus, *Verticillium* sp., was isolated from elms in 8 communities in which it was not previously known, and reports show a total of 96 municipalities in which this fungus has been found in woody plants in Massachusetts.

The extended period of dry weather during the summer of 1941 was a serious cause of tree injury, and therefore, additional trouble associated with winter injury may be expected from this source next year, especially in the case of evergreens, which commonly experience winter injury even in years of normal rainfall.

Because of outbreaks of elm pests during the summer of 1940, a circular<sup>2</sup> was prepared this year and distributed to meet the demands for information on the subject.

A disease known as bleeding canker of hardwoods has been reported to be increasing in New England and, at least under certain conditions, the writers have seen cases in which attempted remedies have caused more damage than the fungus. A fungus, *Phytophthora cactorum*, has been described<sup>3</sup> as the cause of the disease, and an organism believed to be the same fungus has been isolated by the writers from elm, maple, beech and oak in Massachusetts, although evidence of serious disease in the host was not always conspicuous. A possible injection treatment employing "Helione Orange" and requiring skilled technicians has been described<sup>4</sup> following preliminary experimental work. Critical evaluation of the results may be possible at some later date; for the present, however, specific recommendations cannot be made.

Current miscellaneous activities of the project included the preparation of parts of the program of the annual Five-day Short Course for Tree Wardens, the compiling of a progress report,<sup>5</sup> the discussion of wood-destroying fungi<sup>6</sup> at the Eastern Pest Control Operators' Conference, and the preparation of newspaper press releases.

*The Importance of the Investigation of Tree Diseases in National Defense.* In this brief outline of phases of the project which have expanded in relation to national defense, it should be pointed out that it is not possible to distinguish sharply between basic and emergency activities. In fact, none of the following activities are completely new to the project, but increased demands on the part of the public have been classified under three arbitrarily selected groupings among which there is considerable overlapping.

1. Housing projects, new real estate developments, and increased prosperity in general have resulted in increased interest in trees and tree diseases around homes and along streets and highways.

2. As lumbering operations near the point of demand for wood have increased, owing to the necessity for curtailment of transportation costs, supply of labor, shortage of materials, etc., certain types of forest-tree diseases have increased both in the forest and in nearby ornamental trees. The practice of cutting only mature forest trees as a crop maintains a highly desirable, relatively stable biological balance, but only about 5 percent of the nation's forests are operated on this basis in normal times and no hope for an increase in yield-basis operations can be held in the present emergency.

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<sup>2</sup>McKenzie, M. A., and Becker, W. B. Timely spraying protects elms against midsummer defoliation. Amherst, 1941.

<sup>3</sup>Howard, F. L., and Caroselli, N., *Phytopathology* 30:11. 1940.

<sup>4</sup>Howard, F. L. *Science* 94:2441:345. October 10, 1941.

<sup>5</sup>Transcriptions of certain papers presented at the eighth annual five-day short course for tree wardens and other workers with trees. Amherst, March 24-29, 1941.

<sup>6</sup>McKenzie, M. A. Wood decay fungi, published in the "Proceedings of the First Annual Eastern Pest Control Operators' Conference," Amherst, January 13, 14, and 15, 1941.

3. Fungus attack on trees does not end when the tree becomes lifeless wood, although proper seasoning and protective treatment will greatly prolong the life of wood in service. Because of the neglect to consider damage from wood decay fungi and related factors, extensive damage to wooden structures has already been observed and additional trouble may be expected.

For the most part, it is common knowledge that tree disease investigations are essential for defense, but the importance of constant vigilance against tree diseases has been stressed<sup>7</sup> in connection with work on tree problems during 1941. Insidious inroads on public wealth by disease fungi would be rampant if the prosecution of essential disease investigations were relaxed in favor of what, for a thoughtless moment, might appear a greater defense priority need. Disease investigation is primary, vital defense, and in retrospect it is basic to the strong position which this nation holds today.

**Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modification of Environment.** (W. L. Doran.) An Experiment Station bulletin on some of the more immediately useful results of work done under this project has been published<sup>1</sup> and is now in considerable demand.

Work on the vegetative propagation of white pine is being continued. Cuttings rooted in larger percentages and responded more to treatments with root-inducing substances, if they were made with the basal cut at the base of the current year's wood rather than at the base of wood two years old. They rooted better in sand-peat or sand than in sandy soil, and, in one experiment, treated cuttings rooted better in sand than in sand-peat. Best results with January cuttings, 67 percent rooting, were obtained from treatment with indolebutyric acid (200 mg./l., 5 hr.), but there was 58 percent rooting of cuttings treated with naphthaleneacetic acid (100 mg./l., 4hr.), and only 13 percent rooting of the untreated cuttings. Results were less good if cuttings were taken in summer, fall, or earlier in the winter.

Much attention was given to the rooting of cuttings of hemlock and a paper was published<sup>2</sup> on that subject. Cuttings of hemlock, taken in November, rooted best, 100 percent in fourteen weeks, after treatment with indolebutyric acid (100 mg./l., 24 hr.), but naphthaleneacetic acid was also very effective and there were indications that it is sometimes even more effective than indolebutyric acid. Results obtained justify the suggestion that propagators working with late-fall cuttings made of wood of the current year make some use of naphthaleneacetic acid although, with cuttings made with the basal cut at the base of wood two years old, indolebutyric acid in relatively high concentrations was very effective.

A note was published<sup>3</sup> on the rooting of cuttings of umbrella-pine, another species which is usually considered difficult to propagate in this way. They failed to root or to root at all well, treated or not, if taken in September or October; but if taken in January, they rooted 92 percent after treatment with naphthaleneacetic acid (100 mg./l., 2 hr.), decidedly less well if treated with indolebutyric acid. Rooting of December cuttings of *Poncirus trifoliata* was also much more improved by naphthaleneacetic acid than by indolebutyric acid, and lilac cuttings responded better to naphthaleneacetic than to indolebutyric acid. But

<sup>7</sup>McKenzie, Malcolm A. Municipal shade tree problems in national defense. Published in "Proceedings of the Annual Meeting of the Mass. Tree Wardens' Assn.," February 13, 1941.

<sup>1</sup>Doran, William L. The propagation of some trees and shrubs by cuttings. Mass. Agr. Expt. Sta. Bul. 382, 56 pp. 1941.

<sup>2</sup>Doran, William L. Propagation of hemlock by cuttings. Amer. Nurseryman 74: 6: 18-19, 1941 (Contribution No. 413.)

<sup>3</sup>Doran, William L. Propagation of umbrella-pine by hormone-treated cuttings. Florists Exchange 97:9:9. 1941. (Contribution No. 414.)



indolebutyric acid gave much better results with cuttings of Hinoki cypress than did naphthaleneacetic acid.

Untreated cuttings of *Clematis lanuginosa* var. *candida* and the Clematis variety Ramona rooted at least 80 percent if taken in mid-July, less well if taken a month earlier or later, and their rooting was not markedly improved by treatment with indolebutyric acid.

Cuttings of *Daphne Cneorum*, taken in July, rooted 75 percent without treatment, more than 90 percent after treatment with Hormodin No. 1, and less well than the checks if treated for several hours with solutions of root-inducing substances or with water only.

Up to 24 hours' treatment with water, only, did not affect rooting of hardwood cuttings of *Juniperus communis* var. *stricta*, *Ilex crenata* var. *Helleri*, hemlock, or mock-orange.

Best results with these cuttings of mock-orange (100 percent rooting in five weeks) followed treatment with Hormodin No. 3. Cuttings which were given a short (six hours') treatment with naphthaleneacetic acid rooted more slowly although also to the extent of 100 percent, a decided improvement over results with untreated cuttings for they rooted only 58 percent.

Cuttings of the Rhododendron variety Cunningham's White developed better roots if treatment with a sugar solution (3.0 percent) followed treatment with indolebutyric acid. But treatments with sugar solutions, whether applied before, after, or with root-inducing substances, failed to increase the percentages of rooting of fall cuttings of that plant or of *Gordonia* and *Daphne Cneorum*.

**Study of Diseases of Ornamental Herbaceous Plants, Caused by Soil-Infesting Organisms, with Particular Attention to Control Measures.** (W. L. Doran.) Formaldehyde properly diluted may, it was found, be applied safely and effectively to soil immediately after seeding without determining the exact rate of application of the solution to each square foot of soil surface. That, however, is most commonly 1 to  $1\frac{1}{2}$  pints per square foot. Formaldehyde, so applied to soil immediately after seeding that each square foot received 2 cc. of it, controlled damping-off of Delphinium, Viola, and sweet pea well and equally well whether each square foot received 0.75, 1.25 or 2.0 quarts of the solution.

Formaldehyde, 4.9 cc. (1 teaspoonful) in 1 gallon water or, what is the same thing, 1 tablespoonful in 3 gallons, gave perfect and safe control of damping-off of Nemesis, columbine, Zinnia, China aster, hollyhock, Phlox, Nicotiana, Verbena, Lobelia, and two species of Dianthus when it was applied to soil immediately after seeding without determining exactly what volume of the solution was applied per square foot. This method<sup>1</sup> is noteworthy for its simplicity, since there is no working of chemicals, such as dusts, into soil, no waiting, and, because soil must usually be watered immediately after seeding, not a single additional operation is involved.

When formaldehyde 0.5 teaspoonful in 1 gallon of water was thus applied immediately after seeding, it gave fair but less complete control. If this very dilute solution of formaldehyde was applied more than once, that is immediately after seeding and again once or twice or three times more at intervals of two days, there was injury to Scabiosa by three applications, not by two, and to China aster by four applications, not by three. But results with these repeated applications were not promising, for damping-off was just as well controlled by one application immediately after seeding.

Formaldehyde applied to soil not previously disinfected improved the growth of Calendula, Zinnia, and China aster. But when formaldehyde (2 cc. per square

<sup>1</sup>Doran, William L. A simple control of damping-off. Florists Exchange 96:21:10. 1941. (Contribution No. 408.)



foot) was applied to soil which had been steamed five days previously, there was some injury, as compared with growth in steamed soil, and there was certainly no improvement in growth as compared with growth in untreated soil. It is concluded that the stimulatory effect of formaldehyde on growth is due principally or wholly to its freeing the plants of the retarding effects of parasitic soil fungi, and it is concluded further that formaldehyde may be dangerous, as regards its effect on some plants, if applied to soil recently steamed.

Spergon (2.7 gm. per square foot) gave fair control of a root-rot of sweet pea seedlings when applied to soil one day before seeding, and there was no injury. But it gave no protection if seeds were sowed thirty days after soil treatment.

Copper oxybate applied to the surface of soil after seeding failed to prevent damping-off of any species.

Semesan (1.1 gm. in 1.2 quarts water per square foot), applied to the soil surface before seeding but not worked into the soil, was not injurious, controlled damping-off fairly well although not completely, and increased by 27 to 100 percent the numbers of seedlings of marigold, Scabiosa, pansy, and sweet pea which lived. Results were less good when the dry Semesan was worked into the soil, for it was then apparently not sufficiently concentrated near or at the soil surface.

**Chemical Soil Surface Treatments in Hotbeds for Controlling Damping-off of Early Forcing Vegetables.** (W. L. Doran, E. F. Guba, and C. J. Gilgut.) Especial attention was given to the possible use of ammonium hydroxide and ammonium sulfate as soil disinfectants.

Ammonium hydroxide, 12 cc. per square foot of soil surface, controlled damping-off fairly well and without significant injury to seedlings of beet, although seeds were sowed within five days after soil treatment. However, 16 cc. ammonium hydroxide gave better control although, for safety, it was necessary to wait about seven days before seeding.

Ammonium sulfate had little or no fungicidal effect in acid soils, with pH values of 5.0 to 6.0, but it had a decidedly fungicidal action in soil which, as a result of the earlier use of hydrated lime, had a pH value of about 7.0.

When ammonium sulfate and hydrated lime, one part of the former and two parts of the latter by weight, were intimately mixed and this mixture (at the rate of 10 gm. ammonium sulfate per square foot) was worked into moist soil, there was a strong odor of ammonia and damping-off was well controlled. It was, however, necessary on grounds of safety to wait more than five days after soil treatment before seeding.

Hydrated lime alone, applied to soil, usually increased the number of plants which lived and reduced the severity of damping-off, but the disease was not controlled to any such degree as it was by ammonium sulfate and hydrated lime applied together.

**Control of Greenhouse Vegetable Diseases.** (E. F. Guba, Waltham.) Approximately 30 percent of the greenhouse tomato growing area in the fall cropping season of 1941 was planted to the Bay State tomato, developed for resistance to *Cladosporium* leaf mold from hybrids of *Lycopersicum pimpinellifolium* × *L. esculentum*. The new tomato was released for trial in 1939. In the fall cropping season of 1940 a new physiologic form of the fungus, to which Bay State is completely susceptible, was noted at Swansea, Bristol County. In 1941, other instances of the complete susceptibility of Bay State to the new form of *Cladosporium* were observed. Globelle (Ohio) and Vetomold (Ontario) likewise developed for resistance to *Cladosporium*, and derived from red currant, have shared the same experience. The new physiologic form of the fungus is infectious to *L. pimpinellifolium* (Jusl.) Mill. and *L. hirsutum* Humb. & Bonpl., causing

yellowish infection flecks and ultimately necrosis. On the lower surface of the spots, under moist conditions, the fungus sporulates rather freely, although it is much less virulent on Bay State than the original prevalent form of the fungus. Both *L. pimpinellifolium* and *L. hirsutum* shew a high immunity reaction to the original physiologic form of *Cladosporium*. *L. peruvianum* (L.) Mill. is immune to both physiologic forms but *peruvianum* will not hybridize with *esculentum*.

**Causes and Control of Decay of Squash in Storage.** (E. F. Guba and C. J. Gilgut, Waltham.) Gourds instead of squash were treated with various disinfectants and chemical coatings after harvest to determine to what extent these treatments influence keeping. The organisms causing decay of squash similarly attack gourds and the results from such treatments are generally applicable.

The merit of spraying gourds with Bordeaux mixture 4-4-50 and 1 pound calcium arsenate during the growing season was investigated, although it is recognized that the spraying of squash is difficult. The results indicate that fungicidal field treatments result in less decay after harvest and that the progress of decay is further inhibited by coatings of shellac. The value of disinfection between harvest and storage is not clearly shown. A dry ventilated storage following protection in the field with Bordeaux mixture and calcium arsenate was definitely advantageous in the control of decay.

It is apparent, particularly as the result of this season's work with gourds, that considerable infection responsible for decay in storage may take place in the field, without being evident at harvest.

**Gardenia Stem Canker.** (C. J. Gilgut, Waltham.) It was determined from a histological study of gardenia cankers that the hyphae of the infecting fungus, *Phomopsis gardeniae* Hans. & Scott, are confined to the discolored bark and wood of the cankered section of the stem. Cuttings taken from diseased plants and from healthy plants did not become infected when propagated side by side in clean sand, nor did plants from these cuttings become cankered when grown in greenhouse benches.

**Disease Resistance and Heredity of Carnations.** (E. F. Guba cooperating with H. E. White, Waltham.) Approximately 75 varieties of carnations have been studied for their reaction to fungus wilt diseases. Also, growers have indicated the performance of a long list of varieties in relation to these diseases under their respective growing conditions. In a compilation of these reports and tests, it is apparent that certain carnation varieties have rather consistently maintained healthy growth. The wilt diseases under consideration in this study are caused by *Alternaria dianthi* (blight), *Rhizoctonia solani* (stem rot), *Fusarium dianthi* (branch rot) and *F. avenaceum* and *F. culmorum* (stem and root rot), and are not equally prevalent. Frequently, only one of these diseases may be troublesome year after year in the same establishment. Twenty-six varieties showing the greatest promise as sources of disease resistance under natural conditions have been selected for further study. The reactions of these varieties to each wilt disease in so far as available will be more carefully scrutinized under more favorable conditions for disease and artificial methods of inoculation before hybridization studies are undertaken. The results of this program should determine the nature, justification, and direction of further effort in the development of desirable disease-resistant types of carnations.

**Miscellaneous Tests and Experiments.** (E. F. Guba and C. J. Gilgut, Waltham.)

1. *Apple Scab Control.* Ground and chemically prepared sulfurs of a maximum particle size of 50 and 3 microns respectively were compared on an equivalent sulfur basis, and in combination with lead arsenate, and lead arsenate and

lime, for loss of sulfur by weathering, for scab control, and for chemical injury. There were no apples to harvest from the untreated row because of a complete June drop caused by the plum curculio. In this row 20.3 percent of the leaves were scabby and only a small amount of this was primary infection. In the sprayed rows, irrespective of whether the sulfur was coarse or fine, there was no scab.

The results confirm the work of previous years to the effect that sulfur particle size and concentration of sulfur are not as important in scab control as good spraying. Chemical determinations of the residues after spraying revealed that the loss of sulfur by weathering was greater with Magnetic Spray Wettable Sulfur than with dry wettable Flotation Sulfur, early in the season. In both cases more sulfur was retained on the foliage when the combination of sulfur and lead arsenate was used without lime. Fish oil added to Flotation Sulfur, lead arsenate, and lime increased the deposit and retention of sulfur. No improvement was shown by substituting Soya flour for fish oil in the first and second cover sprays. No consistent benefit in the deposit and retention of sulfur otherwise could be shown with the types of sulfur used by the addition of Soya flour.

2. *Copper Dusts for Cucumber and Muskmelon.* Fifteen proprietary and two home-mixed copper dusts containing different sources of metallic copper were tested on cucumber and muskmelon planted in rows of 5 hills of 5 plants per hill. The copper content of the dusts varied from 4.75 to 7 percent. Some contained an insecticide (either 20 percent cryolite, 0.75 percent rotenone, or 5.75 to 10 percent calcium arsenate) added for the control of striped cucumber beetles. The dry summer was unfavorable for the usual foliage diseases, but bacterial wilt and mosaic were present on cucumber.

A proprietary dust containing 5 percent metallic copper and 20 percent cryolite was injurious to both muskmelon and cucumber. On the basis of plant condition and yield, the five best treatments on cucumber were:

6 percent Cu in tri-basic copper sulfate and 0.75 percent rotenone

6 percent Cu in tri-basic copper sulfate

5 percent Cu in copper oxychloride sulfate and 1 percent rotenone

7 percent Cu in tri-basic copper sulfate and 0.75 percent rotenone

5.16 percent Cu in red copper oxide and 0.75 percent rotenone

The best treatments on muskmelon were:

6.5 percent Cu in tri-basic copper sulfate and 0.75 percent rotenone

6.5 percent Cu in tri-basic copper sulfate and 10 percent calcium arsenate

6 percent Cu in tri-basic copper sulfate and 0.75 percent rotenone

5.16 percent Cu in red copper oxide and 0.75 percent rotenone

5 percent Cu in copper oxychloride sulfate and 7.5 percent calcium arsenate

4 percent Cu in copper hydroxide and 7 percent calcium arsenate

The differences between the best copper treatment combinations and a 0.75 percent rotenone dust on muskmelon were not significant in 1941.

3. *Mercury Compounds for Control of Club Root of Crucifers.* In a preliminary exploratory experiment calomel and mercuric bichloride in varying amounts were used for the control of club root of cabbage and cauliflower. Applications were made to seed flats and in the field at different times and by various methods. Because of uneven infestation in the experimental block, the results were indefinite and no conclusions can be made.

4. *Vegetable Seed Treatments for Damping-off Control.* For the second successive year cooperative tests of vegetable seed treatments were conducted under the auspices of the committee for coordinated seed treatment research of the American Phytopathological Society. Weighed amounts of treated seed (treat-



ment based on weight of seed) were furnished to the cooperators by the committee. Five replications of 100 seeds for each treatment and no treatment were counted and planted in randomized blocks.

With cucumber, there was no significant difference between treatment with 0.25 percent red copper oxide, 0.75 percent Semesan, and no treatment. Treatments with 2 percent red copper oxide, 2 percent zinc oxide, and 0.2 percent Semesan showed no significant differences with celery; but with lettuce 2 percent red copper oxide and 2 percent zinc oxide were significantly better, in the order given, than no treatment. With sweet corn, 2 percent red copper oxide, 2 percent zinc oxide, and 0.2 percent Semesan Jr. were no better than no treatment. Cabbage was distinctly benefited by 2 percent zinc oxide and 0.2 percent Semesan. From seed treated with hot water and subsequently with chemical dusts, the stands were reduced, yet they were better than stands from seed treated only with hot water.

The value of a number of dry chemical powders in preventing pre-emergence damping-off and seed decay of lima beans was determined. Spergon-treated seed produced a larger number of seedlings and consequently a greater yield of lima beans than seed receiving any other treatment or no treatment. The second best treatment was red copper oxide, which held a slight advantage in number of seedlings and yield over zinc oxide. Semesan was distinctly injurious to the seedlings, the injury persisted throughout the growing season, and the yield was materially reduced. Although more seedlings grew from seed treated with Semesan than from untreated seed, the total yield from untreated seed was nearly twice that from Semesan-treated seed.

**Effect of Vitamin B<sub>1</sub> at Different Soil Temperatures on Gardenia Chlorosis.** (L. H. Jones.) Gardenia plants became chlorotic at soil temperatures of 55°, 60°, and 65° F. The soil was treated weekly with a solution of thiamin chloride (vitamin B<sub>1</sub>), one part in ten million, used at a temperature equal to the soil temperature. The plants were replicated in sufficient containers so that the thiamin chloride could be applied before, at the observable period when, and after chlorosis appeared. There was no noticeable evidence that thiamin chloride at this concentration could prevent chlorosis induced by low soil temperatures or cure a gardenia plant so affected.

In a later test with chlorotic plants, soil treatment with 100 times the above concentration (1 part in 100,000) did act as a mild remedial measure. New leaves at the unfolding stage were dark green in color, old leaves had the yellowing between the veins supplanted with a healthy green color, and basal shoots developed with dark green foliage. Since this effect took place at about the time of the vernal equinox, it appears that this concentration of thiamin chloride hastened what would have occurred normally a short time later. Since the temperature of the solution when applied corresponded to the soil temperature, the results must be ascribed to the use of vitamin B<sub>1</sub>.

**The Effect of Soil Temperature on Growth.** (L. H. Jones and J. W. Hall.) Corn, tomato, and rose were used as indicator plants. When soil temperatures were altered to 55°, 60°, 70°, 80°, and 90° F., plants which were established in the soil at 75° showed marked effects of temperature on development over a period of 78 days. There was poor growth and no flowering of corn, tomato, and rose plants at soil temperatures of 55° and 60°, but at 70°, 80°, and 90°, the plants grew vigorously and flowered. Corn and rose plants did best at 90°, while the tomato, John Baer, apparently was at its optimum environment at a soil temperature of 80°. Internode length in corn increased up to a soil temperature of 70°, while the internodes of the tomato plant were longest at 80°. The air tem-



perature was maintained at about 80° F. The resulting differences in vegetative and reproductive development are, therefore, attributable directly to soil temperatures.

**The Effect of Root Media on Root Structure.** (L. H. Jones and B. Eames.) Soybean and corn plants grew equally well in either sand or solution culture and could be shifted from one medium to the other without any drastic effect on the root system. Roots in sand cultures were thicker and kinked as compared with the slender, smooth roots grown in solution. A study of the root structure before and after transfer from one type of medium to the other did not disclose any particular modification of root structure other than an increase in the amount of cortex in roots developed in the sand medium.

Geranium cuttings, rooted in sand and transferred to a solution medium, developed new roots at the callus above the level of the solution, the original roots dying in the solution. On the other hand, chrysanthemum cuttings were able to continue growth without the necessity of producing a new set of roots, the original roots being able to function when transferred from sand to a solution.

## DEPARTMENT OF CHEMISTRY

W. S. Ritchie in Charge

**Analytical Service.** (The Department.) Many of the analytical services, formerly performed by the department, have been taken over by the Control Laboratories.

The analysis of various blueberry bushes, particularly for iron and manganese, from an "elemental" fertilizer experiment have been completed for the Department of Pomology.

Samples of a lubricating oil and fungicides have also been examined.

**Testing Analytical Methods.** (E. B. Holland.) The work of several years on a method for the determination of zinc in foodstuffs has been completed, and the procedures appeared as a part of bulletin 379 of this Station.

A study of the method for the determination of fluorine in insecticides has been started, and will receive additional attention during the coming year.

**The Iron, Copper, Zinc, and Iodine Content of Fruits and Vegetables.** (E. B. Holland, C. P. Jones, and W. S. Ritchie.) During the past several years a large number of foodstuffs for both man and beast have been collected, and analyzed for the above elements, as well as for approximate analyses. The results have been classified and tabulated, and published as bulletin 379 of this Station.

**Lignin and Its Relation to the Absorption of Minerals by Plants.** (Emmett Bennett.) This project is being continued in much the same way as outlined previously in other reports. Derivatives of lignin have been prepared. Attempts are being made to fractionate these compounds and correlate such fractions with certain properties of lignin. Limited data do not warrant conclusion at this time.

**Hemicelluloses.** A preliminary attempt is being made to obtain and characterize the hemicellulose fractions of several different species of grass, with the hope of being able to correlate such differences as may exist with differences in species composition. Extractions have been completed and some fractions have been isolated, but as yet no data have been obtained regarding species differences.

**Chemical Investigation of the Onion.** (Emmett Bennett). One paper on the effect of storage of the Ebenezer onion has been published in Volume 39 of the Proceedings of the American Society for Horticultural Science.

A preliminary examination of the soluble carbohydrates indicates that the reducing sugars are probably glucose and fructose. This indication is substantiated by the formation of osazones characteristic of these sugars and by the products of oxidation produced by iodine. According to the latter test the non-reducing sugars are composed of approximately one third aldose sugar and two thirds ketose sugar. This general distribution is to some extent substantiated by the polariscopic behavior of solutions of the mixed sugar fractions. Prior to inversion the optical rotation is usually slightly negative. After hydrolysis the optical activity is decidedly more negative. Such response is usually indicative of an inulide fraction. Further identification of these carbohydrate groups by means of definite derivatives has not been successful. Analytical methods for other compounds concerned with the several phases of the project have also been evaluated.

**Chemical Changes in the Cooking Quality of Vegetables.** (Monroe E. Freeman and W. S. Ritchie.) A new technique for estimating the texture of cooked potato tissue was reported in the annual report for 1940. This technique has been developed into a quantitative method based on the observation that mealy tissue becomes porous on drying while waxy or soggy tissue becomes non-porous. The pore volume of dried slices of tissue can be measured quantitatively by weighing the samples under toluene when the pores are filled with air and when filled with toluene. From these data the weight percent of toluene filling the pores can be calculated and used as an index of texture. The samples were thoroughly dried (in vacuo over  $P_2O_5$ ), weighed in air and then under toluene. The weight of the sample under toluene with all the pores filled with toluene was calculated from the predetermined density of the potato dry matter and the density of the toluene. Toluene indices ranged from 0.15 to values as high as 6.30 percent and were easily reproduced within experimental error of  $\pm 0.05$  to  $\pm 0.10$  percent.

The method was carefully checked by determining the specific gravity of a large number of tubers, baking them, estimating the mealiness by personal judgment, and measuring the toluene index. In all cases there was very satisfactory agreement among these methods for estimating texture. Specific gravity and judging method for texture estimation are rapid but distinguish only four or five grades of texture. Toluene index is a longer and more technical method but it has the distinction of offering a quantitative measure of potato texture or cooking quality and therefore offers a great advantage to research workers in this field.

A storage experiment on potatoes is now under way to demonstrate the applicability of this research tool. Samples of tubers are being stored at 35° and 50° F., and in commercial storage. Samples will be withdrawn at intervals and the texture measured by the three methods as above.

**Physico-Chemical Properties of Starches.** (Monroe E. Freeman.) Very little accurate information is available regarding the chemical and physical properties of the different starches that control the properties of manufactured dextrins, because the industry is operated largely as an art or a craft. The introduction of precise scientific control can undoubtedly be facilitated by the accumulation of data on (a) the chemical and physical properties of the starches, (b) the conversion process itself, and (c) the chemical and physical properties of the dextrins.

Experimental apparatus has been designed, constructed, and tested that intimately mixes a fine spray of acid with a dust cloud of starch. Moisture con-

tent, concentration, and rate of flow of acid and starch can be regulated. An electrometric titration method for measuring small concentrations of acid in starch has been satisfactorily worked out. Apparatus for heating the acidified starch under thermostatic control, uniform agitation, and a controlled atmosphere of air, carbon dioxide, or nitrogen has been designed and constructed.

There exists a real need for an adequate description or definition of the different grades and types of modified starches. This problem has been approached by studies on the physical and chemical properties of commercial dextrins. Analyses for moisture, reducing sugar, copper-reducing power, alkali lability, solubility, iodine color, ash, bound water are in progress on a series of commercial samples and their fractions. Characterization of dextrins by the ratios of significant fractions is also under investigation. Several dextrins have been fractionated by alcohol and the dextrin acetates have been fractionated by organic solvents. Characterization of the dextrin fractions is being carried out by end group assays and viscosity-molecular weight determinations.

Studies of the physical and chemical properties of the starches have begun with an examination of the phosphorus content of several starches. An electro-dialysis technique was developed for quantitatively measuring the inorganic and the organically bound phosphorus in natural starches and in phosphorylated starches. Since size of starch grains is believed to be a factor influencing the character of the manufactured dextrins, a grain size classifier for separating large-grain and small-grain fractions has been designed. Since water relations play an important role in the conversion of starch, studies have been continued on the bound water and free water relationships.

Several methods for determining the bound and free water ratio in starch have shown that potato starch suspensions contain about .3 gram of bound water for each gram of dry starch. Canadian and Russian workers have reported anomalous heat capacities for suspension of hydrophyllic colloids and these data were interpreted as indicating a lower specific heat for bound water thus affording a new method for measuring the bound water. Similar data were collected in this laboratory for starch water suspensions. Careful analysis of the data, however, shows definitely that the above interpretation is erroneous. The anomalous behavior of the starch water suspensions can be accurately described by linear equations embracing a discontinuity at the point where all the water in the starch suspension is bound. An explanation of this phenomenon is awaiting verification by experiments on other systems of hydrophyllic colloids.

**Investigations on the Nutritive Value of Fishery Products as Human and Animal Food.** (Monroe E. Freeman and W. S. Ritchie.) The Progressive Decomposition of Fish Muscle. Studies on the first stages of protein decomposition in fish muscle (Annual Report—1940) were followed by investigation of more extensively decomposed muscle tissue. About twenty-five different fractions were isolated as picrate derivatives from one large sample of haddock muscle. None of these compounds nor their derivatives exhibited clearly defined melting points. Consequently their identification depends on ultimate analyses for carbon, hydrogen, and nitrogen; and determination of molecular weights. Since many of these picrates are violently explosive, special techniques have been devised to facilitate semi-micro combustion and Dumas analyses.

**The Influence of Base Exchange Capacity and of Exchangeable Ions in Massachusetts Soils on the Availability of Potassium.** (Dale H. Sieling.) As a forerunner to the actual investigation of soils collected for this study it seemed advisable to use the soils most readily obtainable in large quantities for physiological



tests with plants. This was done by varying the base exchange capacity and the calcium-hydrogen ratio of the soil artificially over the range of these values observed for the other soils. It was thought that this method of approach would establish certain facts that might then be confirmed by using the naturally occurring soils for similar tests.

The basic soil used in these tests was classified as Agawam fine sandy loam. It had a pH of 5.7, an exchange capacity of 7.13 M. E.\* per 100 grams and an exchangeable calcium content of 2.91 M. E. per 100 grams. The material added to the soil to vary the base exchange capacity was electrodyalyzed bentonite, an inorganic colloidal material having a base exchange capacity of 73.5 M. E. per 100 grams. The calcium-hydrogen ratios of both the soil and the electrodyalyzed bentonite were adjusted to the desired values by liming with calcium hydroxide. The base exchange capacity at any desired calcium-hydrogen ratio was varied between the value for the soil and that for the bentonite by mixing the two constituents.

Pot cultures were prepared by this method which varied in reaction from pH 5.7 to 7.15 and in base exchange capacity from 7.13 to 13.16 M. E. per 100 grams of soil. Phosphorus, potassium, magnesium, and nitrogen were kept constant in the various cultures by adding weighed quantities of the salts of these materials. Duplicate series of pot cultures, with and without added boron, were prepared to check the influence of calcium level and pH on the occurrence of boron deficiency—a condition often associated with "over-liming."

Four tobacco seedlings (Kightlinger's No. 211), five weeks old, were transplanted in each culture. The cultures were watered daily with distilled water and after two weeks three of the four plants of each culture were removed. The remaining plants were grown for a total of eight weeks and then harvested by cutting each plant off at the soil surface. The plants were dried at 60° C. and the dry weight was recorded. The dried plants have been stored and will be analyzed for potassium to see if there was any appreciable difference in the uptake of that element.

During the growing season nitrogen deficiency developed in the plants of some of the cultures even though this element was added from time to time. It seems quite likely that insufficient nitrogen was supplied in the cultures. From the appearance of the plants there was not a lack of boron in any of the cultures or at least there was enough to prevent deficiency symptoms from occurring regardless of the reaction of the soil or its calcium level. The dry weights of the plants were not greatly different although there was a tendency for the dry weight to decrease at any pH as the exchange capacity and the calcium level increased. This observation was most pronounced at pH 5.7. Since nitrogen deficiency was observed in most of the cultures it seems logical to believe that variations in growth or potassium utilization due to calcium-hydrogen ratio or base exchange capacity would be minimized.

These same cultures will be used to grow a second crop during the summer of 1942, with the hope of gaining more information about the influence of these various factors on plant growth and the utilization of potassium by plants.

**The Relationship of Base Exchange Capacity, Exchangeable Hydrogen, and Soil Reaction to the Lime Requirement of Massachusetts Soils.** (Dale H. Sieling.) Samples of the various soils obtained for determining the relationship between lime requirement and the exchange capacity and exchangeable hydrogen were limed with increasing quantities of calcium carbonate. Conditions of liming were established to simulate the actual conditions in the field by placing the soils on top of a layer of sea sand in lacquered metal cans perforated at the bottom.

\*M. E. = milli-equivalent.



This system allowed for drainage of the soils and also the actual determination of the pH of the soils in place. The soils were limed at a rate of from 125 to 1000 pounds of calcium carbonate per acre-inch, based on previously determined volume weights of the soils as they were found in the field.

The reactions of the soils of each series, variously limed, were determined at regular intervals. The soils were wetted with distilled water and allowed to stand overnight to permit drainage of the excess water and the removal of nitrates that may have accumulated as a result of bacterial action. The pH values were determined in duplicate samples of soil dampened with water and with saturated potassium chloride. The pH values obtained with the use of potassium chloride were considerably lower than those obtained with water. The amount of lowering of the pH value due to the presence of the salt showed a relationship to the exchangeable hydrogen content of the soil. The indications are that, in general, soils of higher exchange capacity require greater quantities of lime for neutralization than do soils of low exchange capacity at the same initial reaction. The data obtained have not been sufficient to establish any quantitative relationship between the exchange capacity, the initial reaction, and the lime requirement.

Similar experiments set up under field conditions in the localities from which the soils were obtained gave results parallel to those found in the laboratory, except with the two soils which had received a large quantity of commercial fertilizer for growing onions. It is believed that fertilizer produced a lowering effect on the reaction similar to that observed when potassium chloride was added to the soil under laboratory conditions.

Soils having higher base exchange capacities than those obtained originally for these tests have been secured and will be tested in a similar manner.

**The Effect of Orchard Mulches on the Plant Nutrient Elements in the Soil.** (Dale H. Sieling and J. K. Shaw.) The objectives of this experiment are to investigate the influence of mulching on the accumulation and movement of nutrient cations and of phosphates in an orchard soil and to study the effects of mulching on the trees.

Six mature McIntosh apple trees which had been fertilized with complete fertilizer for the past ten years and had been cultivated during that time were selected for this study. Three separate plots consisting of two trees each were treated as follows: Plot 1 received an application of 290 pounds of hay per 1600 square feet and will be mulched from time to time with hay of known mineral composition; Plot 2 received Fiberglass wool of 2-3 inches in thickness; and Plot 3 was left fallow and will be cultivated in the usual manner.

Soil samples were taken at two systematically located positions under each tree before mulching was started. At each sampling location four samples were taken at specified depths so that any movement of mineral nutrients resulting from mulching might be detected when further samples are obtained and analyzed.

The samples of soil were stored in sealed glass jars to prevent loss of moisture and the subsequent fixing of potassium and other mineral nutrients. After the moisture in the soil had been determined, samples were extracted by the neutral ammonium acetate method and the extracts were analyzed for the exchangeable ions: hydrogen, calcium, magnesium, and potassium.

From the analysis it has been observed that the base saturation of this soil was very low and conversely the hydrogen saturation was very high. In one surface sample the base saturation was as low as 5.2 percent. The amount of exchangeable potassium in the surface soils ranged from 100 to 200 pounds of potassium per acre for a 6-inch depth. This amount of potassium is usually considered adequate for good crop production but may become a limiting factor as the other elements are increased since the subsurface soils contain a much smaller amount of this element. The exchangeable calcium was exceptionally

low, especially in the subsoils, where only 28 pounds of calcium were found per acre for each 6-inch depth. The calcium level of the surface soils was higher but in no case exceeded 270 pounds per acre for a 6-inch depth.

The exchangeable magnesium ranged from an amount too small to be measured by the method employed to 43.2 pounds per 6-inch layer of an acre. It might be suspected that magnesium deficiency would occur on these trees under certain growing conditions, since these amounts of magnesium are considered inadequate for normal plant production.

Total and available phosphorus will be determined on the soils previously collected and on those obtained in the future, to see if the addition of organic matter has any mobilizing effect on phosphate. Mineral analyses will also be made of the samples collected in the future to determine the influence of mulch on the amount or mobilization of the various mineral nutrient elements.

**The Fixation of Arsenic in Soils and the Influence of Arsenic Compounds on the Liberation of Fixed Phosphates.** (Dale H. Sieling.) Anion fixation in soils is very important from the standpoint of the decrease in availability of phosphates added as fertilizers to the soil. This study was undertaken to see whether arsenates were fixed in a similar manner to phosphates and would replace fixed phosphates. If the arsenic from spray residues were fixed, it would show to some extent the reason why such quantities of arsenic do not depress the growth of plants in soils while growth of plants is inhibited in cultural solutions containing the same amount of arsenic. The fundamentals involved in anion exchange or fixation by the soil can best be studied by using pure clay fractions found naturally in soils.

Purified Kaolinite and Halloysite, clay minerals commonly found in soils, have been investigated for their property to adsorb arsenates. It has been found that these clay minerals, as they ordinarily exist in large deposits, do not fix appreciable quantities of either phosphates or arsenates at pH 3.0. Grinding of these minerals in a ball mill for a period of 20 days reduced the particle size to more nearly that of soil clay particles and increased the activity of both minerals in fixing arsenates and phosphates.

Five-gram samples of these minerals were shaken continuously for 24 to 72 hours in stoppered bottles containing measured quantities of a normal solution of either phosphoric or arsenic acid adjusted to pH 3.0 with sodium hydroxide. The fixation was measured by determining the decrease in concentration of the ion in the solution after removal of the clay by centrifuging. Fixation was not instantaneous but followed a pattern somewhat similar to that reported for phosphate by other workers and confirmed in these tests. Arsenate was fixed in quantities practically equivalent to phosphate by the Kaolinite clay but in somewhat smaller amounts than phosphate by the Halloysite; however both arsenate and phosphate fixation by pulverized Halloysite exceeded the amounts of these ions fixed by Kaolinite.

Further study is being conducted to establish the relative ability of each of these two negative ions to replace the other when it has been fixed by these clays.

## CONTROL SERVICE

Philip H. Smith in Charge

The Fertilizer, Feed, and Seed Control Laws and the Dairy Law are all administered as one service. In addition, a large amount of work is done not only for other departments of the institution, but also for other State institutions and for citizens as well.

**Fertilizer Inspection.** Records for the year show that 118 firms have registered 501 brands of mixed fertilizers and fertilizing materials and 45 brands of agricultural lime and gypsum. The gross receipts from the registration of the fertilizer and lime products and from fertilizer tonnage fees were \$14,711.41.

For inspection purposes 1,746 samples, representing 490 brands and 8,433 tons of materials, were drawn from stock found in the possession of 393 agents or owners located in 144 towns and cities of the State.

The following summary shows the character of these substances, as well as statistics with reference to their inspection.

	Brands Registered	Brands Collected	Samples Drawn
Mixed fertilizers.....	330	299	1,021
Ground bone, tankage and fish.....	35	35	190
Nitrogen products, mineral and organic.....	48	41	151
Phosphoric acid products.....	26	23	112
Potash products.....	24	23	85
Dried pulverized natural manures.....	23	22	73
Nitrate of potash.....	3	3	9
Peat products.....	3	2	2
Wood and cotton hull ashes.....	6	4	6
Emjeo (30% magnesium oxide).....	1	—	—
Miscellaneous.....	2	1	5
Lime products.....	45	37	92
Totals.....	546	490	1,746

**Feed Inspection.** During the fiscal year 1,331 samples of feeding stuffs were officially collected and examined in the control laboratories. The gross receipts from the registration of feeding stuffs in 1941 were \$27,220, derived from 1,361 brands at \$20 each.

**Dairy Law.** During the year ending December 1, 1941, 6,738 pieces of Babcock glassware were tested; 107 certificates of proficiency were awarded; and 239 creameries, milk depots, and milk inspectors' laboratories were visited in order to check methods and to pass upon equipment in use. As a result of this inspection, four machines were condemned. These will be either replaced or put into condition to operate satisfactorily.

**Miscellaneous Analytical Work.** (Fertilizer and Feed Laboratory.) In addition to the work required by the several regulatory activities under its administration, Control Service is interested in collaborative work with other departments of the Experiment Station and College; the examination of samples of feeds, fertilizers, and other agricultural products submitted by citizens of the State; the testing of feeds and fertilizer bought by State institutions; and investigational work on new methods of chemical analysis for the Association of Official Agricultural Chemists.

In order to indicate the wide scope of the work, the following statistical data are appended:—

Fruit spray residue.....	16
Feeds, from farmers and dealers.....	57
Feeds, from State institutions.....	892
Feeds and forage crops, Experiment Station.....	182
Fertilizer mixtures.....	12
Ice Cream.....	130

Insecticides and fungicides .....	2
Limestone (AAA distribution) .....	12
Milk .....	362
Ore .....	8
Peat .....	1
Poultry feces (In connection with experiments) .....	9
Poultry grits .....	6
Referee and check samples, fertilizer and feed .....	11
Specimens for mineral poison .....	3
Superphosphate (AAA administration) .....	11
Water .....	4
Miscellaneous .....	19

**Seed Control.** From December 1, 1940, to December 1, 1941, the Seed Laboratory received and worked 3024 samples of seed, of which 942 were collected by the State Commissioner of Agriculture and 2082 were sent in by seedsmen, farmers, and various State institutions. In addition, 209 samples of flower seeds, for field tests only, were received from the State Commissioner of Agriculture.

Classification of these samples, with the total number of laboratory tests involved, is shown in the following summary. It will be noted that 3998 tests were required for the 3024 samples; 672 for purity, and 3326 for germination.

Number of Samples		Number of Tests	
		Purity	Germination
544	Field Crops for Purity and Germination .....	544	544
2	Field Crops for Purity Only .....	2	—
235	Field Crops for Germination Only .....	—	235
81	Lawn and Other Types of Mixtures for Purity, Germinations involving 393 ingredients .....	81	393
35	Lawn Mixtures for Purity Only .....	35	—
7	Lawn Mixtures for Germination Only, Germinations involving 36 ingredients .....	—	36
1926	Vegetables for Germination Only .....	—	1926
46	Herbs for Germination Only .....	—	46
16	Flower Seeds for Germination Only .....	—	16
2	Flower Seeds for Purity Only .....	2	—
8	Flower Seeds for Purity and Germination .....	8	8
13	Tree Seeds for Germination Only .....	—	13
109	Tobacco Seeds for Germination Only .....	—	109
3024	Totals .....	672	3326

Field tests to determine trueness to type were conducted in cooperation with the Departments of Olericulture, Floriculture, and Agronomy, which tested 220 samples of vegetable seeds, 209 samples of flower seeds, and 30 samples of oats, respectively.

The Seed Laboratory cleaned 90 lots of tobacco seed for Connecticut Valley farmers. The gross weight of the tobacco seed was 131.28 pounds and the net weight for the cleaned seed was 102.17 pounds.

Corn, oats, barley, and wheat, (162 samples), purchased by various State institutions, were examined for conformity to grade purchased; and 98 samples of ground cattle and poultry feed, collected by inspectors or sent in by dealers and farmers, were examined microscopically.



## THE CRANBERRY STATION East Wareham, Massachusetts

H. J. Franklin in Charge

### Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.)

*Hill Fireworm (Tlascala finitella* (Walker)). One and a half acres of the Summit Cranberry Company's bog at Greene, R. I., replanted in the spring of 1941, were seriously infested in the hills by this insect in mid-July. Vines planted there in 1940 were also attacked but less severely and more along the runners lying on the sand than in the hills. These infestations were curbed completely by spraying and dusting heavily with rotenone materials.

About 50 acres of heavy vines of the Burrage bog at South Hanson, Mass., were found to be infested throughout by this insect from July 12 to August 12, 1941. The worms were everywhere rather plentiful there in the thicker clusters of vines during the latter half of July, being mostly in their tubes of frass and silk well down among the vines but considerably above the bog floor. They did considerable, but not severe, damage by devouring under leaves and blossoms. The superintendent of the bog said it had been similarly attacked by this pest in 1940.

Many of the worms were about full grown on July 19, 1941. A few were still present in their tubes among the vines of the Burrage bog on August 12. The largest were about thirteen sixteenths of an inch long, with the head black, the cervical shield black with a much-broken pale yellow stripe along its front margin, the body dark brown, striped lengthwise on the back and sides, except toward the hind end, with about eight narrow and broken pale yellow stripes, these being most conspicuous toward the front end. The first moths to appear in confinement emerged August 8 and more came out from August 10 to 20. Many live pupae remained on November 18.

Some of these worms were found in their tubes among the foliage of cultivated swamp blueberry bushes at the station.

*Cranberry Root Grub (Amphicoma vulpina)*. Some of these grubs were sent to the Japanese and Asiatic beetle laboratory at Moorestown, New Jersey, in January 1941, to have their susceptibility to the milky disease organism determined. Mr. C. H. Hadley, in charge of the laboratory, reported later as follows:

With further reference to my letter of January 10th regarding tests to determine the susceptibility of the cranberry root grub, *Amphicoma vulpina*, to the milky disease organism, we have completed the preliminary tests with the material which you sent me in January. Negative results were obtained both by injection tests and feeding tests with the type A milky disease organism, *Bacillus popilliae*. No evidence of milky disease development was observed either by macroscopic examination or upon microscopic examination of the blood of the injected individuals. Neither was there any indication of development of the organism in larvae which had been given opportunity to feed in infected soil. We must, therefore, conclude that this species of larva is not susceptible to milky disease infection.

Late in the spring, one of the cranberry growers started further tests of paradichlorobenzene as a control for this pest, applying the chemical with a fertilizer spreader at the rate of 1200 pounds an acre and covering it at once with about an inch of sand. His plots were examined late in August and nearly all the grubs were found to have been killed, even where flooding for frost protection and for insect control had been done soon after the treatment was applied. This treatment probably will be useful in special situations, as on bogs that cannot be treated with cyanide because they drain into public water supplies, or perhaps on bogs with a surface soil too dense to take in the cyanide solution readily.

Quite a number of bogs were reflowed from mid-May to mid-July, 1941, to check severe infestations of the root grub. This treatment was generally fairly successful, as it usually has been heretofore, but it was found that in several cases some grubs survived.

*Cranberry Fruit Worm (Mineola vaccinii)*. Arsenate of lead, 8 pounds in 100 gallons of water with a casein spreader, applied at the rate of 400 gallons per acre at the times when derris and cryolite are most effective, controlled this insect very well on experimental plots, but less completely than derris or cryolite. Xanthone, both in a spray and in a dust, failed to affect it appreciably.

*Gypsy Moth (Porthetria dispar)*. Cryolite, 14 pounds in 100 gallons of water, 400 gallons an acre, failed to cause much reduction in the number of maturing caterpillars on a bog, as did also dusting with 100 pounds of natural cryolite per acre.

*Cranberry Girdler (Crambus hortuellus)*. Fifty pounds of 4 percent rotenone derris dust (without activator) to an acre killed nearly all the moths of this pest on a treated area, but was not quite so effective as pyrethrum.

*Black-headed Fireworm (Rhopobota)*. An interesting development was the use of a mixture of cryolite and impregnated pyrethrum dust. Treatments with this mixture cost no more than those with clear pyrethrum dust and seemed to have greater value, especially with the first brood. The cryolite provides a considerable control after the pyrethrum ceases to act and so takes care of most of the young worms as the eggs continue to hatch.

*Prevalence of Cranberry Pests*. The relative general abundance of insect pests on Massachusetts bogs in the 1941 season was as follows:

1. Gypsy moth more abundant and destructive in Plymouth County than for many years, but much reduced on the middle and outer Cape, not giving much trouble there.
2. Blunt-nosed leafhopper (*Ophiola*) reduced as in recent years, because of general treatment.
3. Cranberry fruit worm only moderately troublesome and through working early; much less prevalent than in 1940, less eggs being laid by the moths, and the eggs being attacked by the *Trichogramma* parasite more severely and generally than usual.
4. Black-headed fireworm less abundant than usual and less than in 1940.
5. Firebeetle (*Cryptoccephalus*) generally very scarce, but abundant on 10 acres of a bog in Norton.
6. Spanworms about the same as in 1940.
7. False armyworm (*Xylena*) even more prevalent than in 1940; more troublesome than for many years. Blossom worm even less prevalent than in 1940.
8. Cranberry girdler more harmful than in 1940.
9. Cranberry weevil about as in 1940.
10. Cranberry spittle insect (*Clasoptera*) and tipworm (*Dasyneura*) rather more troublesome than in 1940.
11. Spotted fireworms (*Cacoecia*) very few.

**Control of Cranberry Bog Weeds.** (Chester E. Cross.) Paradi-chlorobenzene, naphthalene, ferric sulfate, ferrous sulfate, copper sulfate, borax, kerosene, and a special petroleum oil, PD-428D, were tried on various kinds of bog weeds, 276 plots being treated. The results of many experiments have shown that many cranberry weeds can be killed in May and early June by treatments largely ineffective later in the season.

**Paradichlorobenzene.** It was observed in August 1940 that poison ivy (*Rhus Toxicodendron*) growing on areas of bog treated with 1200 pounds of this chemical to the acre and then resanded with half an inch of sand lost all its leaves, while cranberry vines on the same ground showed no injury. Cranberry bog plots with poison ivy were treated in September 1940, with amounts ranging from 800 to 5400 pounds per acre and then resanded with half an inch of sand. All these plots, except that which received 800 pounds per acre, showed a kill of three fourths of the ivy in the summer of 1941, with no injury to the cranberry vines or their crop. Paradichlorobenzene applied in June, July, and August, 1941, killed the ivy well, 1200 pounds per acre being as effective as greater amounts. A cover of three quarters of an inch of sand seemed necessary for the best results. Frost flooding two weeks after the chemical was applied did not seem to affect the kill of ivy.

Paradichlorobenzene, 1200 pounds per acre applied in June, July, and August and covered with three fourths of an inch of sand, killed 80 percent of considerable growths of chokeberry (*Aronia melanocarpa*), this weed losing all its leaves and its roots becoming brown and rotten in 12 days.

The following weeds endured paradichlorobenzene treatments as well as cranberry vines: Horse brier (*Smilax rotundifolia*), saw brier (*S. glauca*), small bramble (*Rubus hispidus*), coarse bramble (*R. villosus*), horsetail (*Equisetum*), asters (*A. spectabilis* and *A. multiflorus*), sphagnum moss, sensitive fern (*Onoclea sensibilis*), shield fern (*Thelypteris palustris*), bayberry (*Myrica carolinensis*), sweet gale (*Myrica Gale*), wild bean (*Apios tuberosa*), red maple (*Acer rubrum*), hardhack (*Spirea tomentosa*), three-square grass (*Scirpus americanus*), spike rush (*Eleocharis tenuis*), and partridge pea (*Cassia chamaecrista*).

**Naphthalene.** Tests with naphthalene at 800, 1600, and 2400 pounds per acre were made in June, July, and August on poison ivy and other bog weeds. The chemical was broadcast by hand and covered with sand as in the paradichlorobenzene treatments. It failed to kill more than 10 percent of poison ivy even where it was applied in greatest quantity and had no effect on horsetail, hardhack, soft rush, reed canary grass, three-square grass, royal, sensitive, and shield ferns, or cranberry vines.

**Ferric Sulfate.** This year 32 plots with many kinds of cranberry bog weeds were treated with ferric sulfate at various rates. A carpet of young royal ferns on a peat-bottomed bog with poor drainage was killed with a broadcast treatment of 15 pounds per square rod, no cranberry vines or flower buds being hurt by it; 10 pounds per rod killed only 70 percent of the ferns and 20 pounds killed 8-10 percent of the cranberry branches.

One handful of ferric sulfate proved enough to kill 5-7 medium-sized cinnamon ferns. The vines around ferns treated with this amount under dry conditions showed no injury.

Ferric sulfate, 15 pounds per square rod, completely eliminated shield and sensitive ferns.

Single handfuls of ferric sulfate killed 2-4 clumps of soft rushes (*Juncus effusus*).

Spike rush (*Eleocharis*) was killed easily with 15 pounds of ferric sulfate or 35 pounds of ferrous sulfate to the square rod, but ferrous sulfate needs rain or a sprinkling of water to make it effective.

Ferric sulfate at 15-20 pounds per square rod must be used in late May or early June to be effective on rice cut-grass. This weed when 6 or more inches high, in July and August, tolerated a great deal of the chemical.

A little ferric sulfate at the base of each shoot was effective on wild bean. A handful was enough for at least 6 shoots.



**Ferrous Sulfate.** Dry ferrous sulfate, 40 pounds per square rod used early in June, killed 90 percent of long-leaved asters (*Aster spectabilis* and *A. Novi-Belgii*). The same treatment applied in July, when the asters were a foot high, killed only 25 percent.

Spike rush (*Eleocharis tenuis*) was controlled well with ferrous sulfate broadcast at the rate of 40 pounds per square rod, June applications giving nearly complete kills while those made in July and August were less effective. Two competent growers reported the treatment as 95-100 percent effective when used in May.

Ferrous sulfate must be brushed off the cranberry vines when it is used in broadcast applications of 30 or more pounds per square rod.

**Kerosene.** Repeated experiments with kerosene showed the least injury to cranberry vines when it was applied before 10 a. m. or after 5 p. m. in June, July, and August. Mid-day applications, even with the air temperature below 80° F., injured cranberry tips and runners considerably. Recent tests of kerosene spraying in the early morning when the vines and weeds are wet with dew showed no injury to the cranberry vines, while the weeds seemed as sensitive to the kerosene as when sprayed under dry conditions.

Water white kerosene, 600 gallons per acre, gave 100 percent kill of loosestrife (*Lysimachia terrestris*) when applied before this weed was 5 inches high. The same kill was obtained later by mowing the taller loosestrife plants before spraying with kerosene.

**Borax.** Commercial borax, applied in July, 100 pounds per acre, killed Joe-Pye weed (*Eupatorium purpureum*) with little or no injury to cranberry vines. Heavier applications injured the vines.

**Root Grub Flooding and Bog Weeds.** Nine bogs flooded from mid-May to mid-July to kill grubs were examined in early September and late October to learn the effect of this flood on bog weeds. It had prevented no annual weeds from growing on the bogs but had shortened the season of several species so that they had failed to flower; others, like summer grass (*Panicum verrucosum*) and ragweed (*Ambrosia artemisiifolia*), had not attained normal growth but had flowered and seeded profusely; the trailing bramble (*Rubus hispidus*), rice cut-grass (*Leersia*), and wild bean (*Apios tuberosa*) had been reduced 90 percent; and the coarse bramble (*Rubus* sp.) and *Juncus* rushes had been killed entirely. Half the loosestrife (*Lysimachia*) and three fourths of the hair-cap moss (*Polytrichum*) had been killed where the water was over 18 inches deep, but these weeds had not been reduced much where the water was shallow. As many as 28 other species of perennial weeds grew more or less normally after the flooding.

## COOPERATIVE CRANBERRY INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture, in cooperation with the Massachusetts Agricultural Experiment Station

H. F. Bergman, Senior Pathologist, Division of Fruit and Vegetable Crops and Diseases, in Charge

**Development of Strains of Cranberry Resistant to False Blossom.** (H. F. Bergman.) Nearly 1800 hybrid cranberry seedlings in pots were brought to East Wareham from Beltsville, Maryland, early in June 1941. This lot is part of the seedlings obtained from crosses made at East Wareham in 1938. They were set out temporarily on the State Bog and are to be transferred in 1942 to an area of new bog provided by the A. D. Makepeace Company of Wareham, Mass-



achusetts, under the terms of a memorandum of understanding drawn up with that company. Several other lots of seedlings from crosses made at East Wareham are set out in permanent locations on the State Bog where they will be allowed to grow until final assessment of their worth for propagation can be made.

**Oxygen Content of Winter Flooding Water in Relation to Injury to Cranberry Vines.** (H. F. Bergman.) Studies of the effects on cranberry vines of a lack of oxygen in the water during the winter flooding period were continued, in an attempt to correlate various types of injury with known low contents of dissolved oxygen over approximately known periods and to obtain additional data as to the conditions under which injury occurs. Three cylindrical sheet-iron tanks, about 5 feet in diameter, were placed on the State Bog, one each on sections planted with vines of Early Black, Howes, and McFarlin varieties. The bog was flooded on December 5, 1940, and froze over within a few days and remained frozen continuously until about the middle of March. Covers to exclude light and thereby prevent the liberation of oxygen by photosynthesis were placed on the tanks on January 18, 1941.

The importance of photosynthesis in maintaining the dissolved-oxygen content of the water on a winter-flooded bog covered with ice is shown by the course of this oxygen content outside and inside the tanks during the winter. The amount of dissolved oxygen in the water outside the tanks on Howes, Early Black, and McFarlin vines increased from 5.3, 6.4, and 6.8 cc. per liter, respectively, on January 15 to 7.2, 7.9, and 8.3 cc. per liter, respectively, on January 24 as a result of photosynthesis in the cranberry vines. A heavy snowfall on January 24 prevented photosynthesis by excluding light, while the consumption of oxygen by respiration of the cranberry vines and of organisms which decompose organic matter continued. As a result the dissolved oxygen in the water outside the tanks decreased to less than 2 cc. per liter, although probably for not more than 5 or 6 days. A heavy rain on February 7 removed most of the snow and the remainder froze into the ice. Thereafter, the dissolved oxygen in the water outside the tanks on Early Black and McFarlin vines increased rapidly, and by February 12 it had come up nearly to the same content as on January 24. The oxygen content of the water outside the tank on Howes vines remained near 2 cc. per liter until February 20 when it also began to increase.

The dissolved oxygen in the water inside the tanks on January 15 varied from 4 to 5 cc. per liter. Because of the exclusion of light by the covers, little or no photosynthesis could take place and the oxygen content of the water decreased steadily. By January 24 and from then until February 27 there was no dissolved oxygen in the water inside the tank enclosing vines of the Howes variety, and not more than 0.4 cc. per liter from February 27 until March 20. In tanks enclosing the other two varieties of vines there was less than 1 cc. of oxygen per liter of water for about a month from February 1 to March 1 except in the tank on Early Black vines where the oxygen content of the water increased to slightly more than 2 cc. per liter for a few days around February 12. On February 28 nine inches more water was pumped onto the bog which brought the oxygen content of the water up to more than 2 cc. per liter. Thereafter, except for a few days about March 13, there was never less than this amount of oxygen in the water. Soon after March 20 the ice went off the bog and the dissolved-oxygen content again increased.

The water was taken off the bog on April 1, 1941, and the tanks were then removed. Counts were made during the summer and autumn to ascertain the average number of flowers and fruits per upright, the percentage of buds killed, and the percentage of flowers that set fruit on vines of each of the three varieties both inside and outside the tanks where the dissolved oxygen content of the water

during the winter flooding period was known. The yield of berries of each variety inside the tanks and on measured areas outside was determined.

The effect of an insufficient supply or of complete deprivation of oxygen over a period of a month or more during the winter flooding period is shown clearly by the reduction in yield of berries from vines inside the tanks in comparison with vines outside. Furthermore, the yield outside but near the tanks was very much less than that from vines on slightly higher ground and therefore less deeply flooded. The yields, in barrels per acre, were as follows: Early Black, inside tank 28, outside near tank 34, on slightly higher ground 75; Howes, in the corresponding locations, 50, 72, and 110; and McFarlin, inside tank 39, outside on higher ground 81.

Although the dissolved-oxygen content of the water on the less deeply flooded areas during the winter was not determined, it has been found repeatedly that the oxygen content of water is less in deep places than in shallow, even a few inches making a significant difference, particularly when there is ice over the bog. It is probable, therefore, that the oxygen content of the water in the less deeply flooded "high" places did not fall below 2 cc. per liter for more than one or two days during the winter, if at all. This indicates that if the dissolved-oxygen content of the water is less than 2 cc. per liter for even a few days the yield is greatly reduced. A longer period of oxygen deprivation caused a further reduction in yield, but even within a variety the reduction was not proportional to the length of time during which the oxygen deficiency existed. Prolonged oxygen deficiency affected vines of different varieties differently. There was no oxygen in the water inside the tank on Howes vines for nearly two months; yet these vines yielded better than Early Black vines inside a tank in which the oxygen in the water was less than 1 cc. per liter for not more than a month and approached exhaustion for about two weeks only. This probably is because the Early Black vines had been badly injured by a lack of oxygen in the water during the flooding period of the winter of 1939-40 and therefore were more susceptible to injury.

The first effect of an oxygen deficiency during the winter flooding period is to reduce the number of flowers that set fruit. Injury of this kind apparently may occur if there is less than 2 cc. of dissolved oxygen per liter in the water for as short a time as 3 or 4 days. In all three varieties the percentage of flowers setting fruit was lowest on vines inside the tanks, where the oxygen deficiency was greatest, and was lower on vines in slightly deeper water than on those most shallowly flooded, although in some cases the difference was small.

A greater deficiency of oxygen or a deficiency over a longer time causes the death of flower buds and then of the uprights on which the flowers are borne. The percentage of dead buds on vines of all three varieties in the areas outside but near the tanks was considerably greater than it was on vines on slightly higher ground. In the Early Black and Howes varieties the percentage of dead buds on vines inside the tanks was slightly less than on those outside, whereas it should have been greater. One reason for this discrepancy may be that more of the flower buds on vines inside the tanks than on those outside were killed at such an early stage of development that they were not detected when the counts were made. This is indicated by the lower average number of flowers per upright for these varieties on vines inside than on those outside the tanks. Another reason is that in making the counts only flowering uprights were taken; no attention was paid to sterile ones, a considerable proportion of which probably were flowering uprights on which the buds had been killed at a very early stage of development. For the same reasons the values for the percentage of flowers setting fruit on vines of the Early Black and Howes varieties inside the tanks are higher than they would otherwise have been.

The average size of berries from vines inside the tanks was smaller than that of

berries from vines just outside the tanks or from vines on slightly higher ground. Berries of the Early Black variety showed the greatest difference. Those from vines inside the tank averaged 158 to the cup ( $\frac{1}{2}$  pt.); from vines just outside, 118 (average of 93 counts); and from vines on slightly higher ground, 110 (20 counts). The average number of berries per cup for the other two varieties was as follows: Howes, inside tank 115, outside near tank 105, outside on slightly higher ground 100; McFarlins, inside tank 94, outside near tank 94, on slightly higher ground 84. Many berries failed to grow to a size large enough to be picked. The proportion of these berries was greater from vines inside the tanks or from vines outside near the tanks than from vines on higher ground.

The reduction in the size of picked fruits and the failure of berries to grow to a size large enough to be picked probably is due to an inadequate food supply during the summer because of injury to the leaves of the preceding season which reduced their capacity to synthesize carbohydrates. Vines of all three varieties inside the tanks lost more of their old leaves than did vines outside. This was true especially of Early Black which lost nearly all the old leaves from vines inside the tank. Even when old leaves remained on the vines, many of them were injured and probably their effectiveness in the formation of carbohydrates was greatly reduced.

The following conclusions are drawn: Injury to cranberry vines occurs when the dissolved-oxygen content of the water falls below 2 cc. per liter. This happens apparently only when the ice on a winter-flooded bog is covered with snow, which excludes light and thereby prevents photosynthesis and the resultant liberation of oxygen which ordinarily keeps the oxygen content of the water high enough to prevent injury. The injurious effect on cranberry vines of a lack of oxygen for several days to a few weeks is shown ultimately in the reduction of the crop. Reduced yields are the direct result of (1) reduction in the number of flowers setting fruit, (2) death of flower buds and flowering uprights, and (3) reduction in the size of fruits, both those harvested and those too small to pick.

## DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

**Studies on Chocolate-Flavored Milk.** (W. S. Mueller.) The study of chocolate-flavored milk, with especial emphasis on its nutritive value, continues to be a major project in this department. For a long time it had been assumed that the well-known nutritive properties of plain milk were also present in chocolate-flavored milk. In 1937 it was discovered that milk containing 2.5 percent or more of cocoa was not equal in nutritive value to plain milk, when fed to white rats. Since then experiments have been in progress to learn more about the various constituents of cocoa and their possible effects upon the nutritive value of the milk. In addition to the nutritional studies, investigations on improving the method for processing chocolate milk are in progress.

1. *The Effect of Cocoa Upon Digestibility of Milk Proteins.* (L. D. Lipman and W. S. Mueller.) The addition of cocoa to whole milk powder in quantity equivalent to approximately 3.6 percent by weight on a fluid milk basis reduced the digestibility of the milk protein 7.8 percent. The kind of cocoa, Dutch or American-process, and the inclusion of 7.1 percent of cocoa fat in the ration, did not significantly affect the percentage reduction. Proteins of the Dutch and American-process cocoa were found to be 38.1 and 44.5 percent digestible, respectively. The results of this study were published in the *Journal of Dairy Science* 24, May 1941.



2. *The Significance of Tannic Substances and Theobromine in Chocolate Milk.* (W. S. Mueller.) The relative toxicity of pure theobromine, pure tannic acid, and two cocoa powders varying in content of tannic substances was determined by feeding these substances in a basal diet to white rats. Theobromine was non-toxic to albino rats when the ration contained 0.27 percent of this alkaloid, and tannic acid was toxic when the ration contained 2 percent of this substance. These amounts of tannic acid and theobromine in the diets were equal to those in a chocolate milk made with 3.6 percent cocoa powder which contained 12.15 percent tannic substances and 1.7 percent theobromine. A cocoa powder containing 12.15 percent of tannic substances was more toxic than a cocoa powder containing only 2.67 percent of tannic substances, but was less toxic than pure crystalline tannic acid. A concentrated extract of cocoa was non-toxic to rats when fed at the rate of 8 percent of the ration. The hemoglobin levels of the blood of rats fed theobromine, crystalline tannic acid, and cocoa powder containing varying amounts of tannic substances did not vary from the normal enough to be of any significance. Results from this study indicate that the toxicity from cocoa can be greatly reduced by selecting a cocoa or chocolate which is low in tannic substances, or preferably by using an extract of cocoa as the flavoring material when feasible.

3. *The Availability of the Iron of Cocoa and of Additional Iron when Associated with Cocoa.* (F. Kinder, H. S. Mitchell, and W. S. Mueller.) This study is reported by the Department of Home Economics Nutrition.

4. *Effect of Adding Cocoa to Cow's Milk on the Utilization of Calcium and Phosphorus.* (M. R. Cooney and W. S. Mueller.) This study is reported by the Department of Home Economics Nutrition.

5. *The Bacteriology of Chocolate Milk, Chocolate Syrup, and Cocoa Powders* (R. W. Swanson, J. E. Fuller, and W. S. Mueller.) This study is reported by the Department of Bacteriology.

6. *Effect of Cocoa on the Vitamin C Content of Milk.* (W. S. Mueller.) Vitamin C is present in fresh raw milk to the extent of 12 to 20 mg. per quart. If this could all be retained, milk would be a significant source of vitamin C, since the higher figure is about half the daily requirements of an adult. Therefore, the handling of milk from the time it is drawn until it is consumed, in a manner which will conserve the vitamin C, is an important problem today.

If chocolate milk is substituted for plain milk, it is important to know what effect the cocoa has upon the retention of vitamin C. Preliminary studies on the relative retention of vitamin C in plain milk and chocolate milk have been made, using the 2, 6-dichloro-phenol-indophenol in both visual and electrometric titrations. Results of these studies indicate that the addition of cocoa to milk hastens the destruction of vitamin C. When both milks were stored, under identical conditions, the plain milk lost 22 percent of the original vitamin C, while the loss for chocolate milk was 77 percent. This difference in loss of vitamin C is typical of the results obtained. Studies are also being made to determine which method is most suitable for measuring the vitamin C content of chocolate milk.

7. *Effect of Cocoa on the Coagulation of Milk.* (W. S. Mueller.) It has been reported by a foreign investigator that cacao bean contains an enzyme with rennet effect. Dry, it withstands heating to 248°-284° F. and may, therefore, be found in cocoa powder. The optimum temperature of the enzyme is 149° F. and the optimum pH is below 6.3. By heating a suspension of cocoa powder in water (176° F.), the enzyme will be destroyed.

Since the knowledge of this enzyme may be of practical interest to the consumer as well as to the manufacturer of cocoa, a study was undertaken to deter-



mine whether cocoa powders commonly sold in this country contain such an enzyme. In preliminary studies 25 samples of cocoa powder have been investigated. When one percent of cocoa powder, by weight, was added to good quality milk (.16 percent acidity), only one cocoa powder coagulated the milk shortly after heating at 149° F. for 30 minutes. Further investigation will be made, using milk of higher acidity and of a low protein stability, and also adding a larger amount of cocoa to the milk.

8. *The Effect of Various Methods of Pasteurization on Chocolate Milk.* (W. S. Mueller and A. M. Shipley.) Further experiments in pasteurizing chocolate-flavored milk by the Electropure process substantiate in a general way the results of last year. However, in the latest trials, the Electropure method was more efficient in the reduction of the bacteria count of highly viscous chocolate milks.

**Cooperative Study with the American Dairy Science Association Committee on Methods for Determining the Curd Tension of Milk.** (W. S. Mueller.) The final report of the committee on methods of determining the curd tension of milk was published in the *Journal of Dairy Science*, 24, September 1941.

**Improving the Flavor and Keeping Properties of Milk and Some of its Products.** (W. S. Mueller and M. J. Mack.) A major flavor defect of orange or lemon ice and sherbet is the development of terpene odors and flavors, as a result of the oxidation of the oil in the flavoring material. It seems logical that this flavor defect could be prevented or minimized by the addition of an antioxidant. Therefore, the antioxygenic effect of oat flour and of a concentrated extract of oat flour was studied by adding 0.5 and 0.1 percent of these substances, respectively, to lemon and orange ices. Fresh orange and lemon juice were used as the flavoring materials. The control samples developed a harsh flavor after four days, while the samples containing the antioxidants had a typical orange and lemon flavor for several weeks. In the concentrations used, the concentrated extract of oat flour was slightly more effective than the powdered oat flour. A protective action was also noted when a sugar which had been treated with the oat flour concentrate was added to the orange and lemon ices.

Cocoa flour was found to be an effective antioxidant when added directly to milk. Also cocoa flour and oat flour possessed antioxygenic properties when used for treating paper milk-container stock.

Factors which may affect the solubility of the antioxidant oat flour in ice cream mix and milk are being investigated. The effect of temperature of the milk at the time the oat flour is added has been studied. No significant differences were noted for temperatures ranging from 50° to 160° F.

**The Use of Corn Syrup Solids in Ice Cream and Ices.** (M. J. Mack and J. H. Nair.) The use of dried corn syrup as a sweetener in frozen dairy products was discussed in a previous publication. (Corn Syrup Solids Improve Frozen Dairy Products. Lynn R. Glazier and Merrill J. Mack. *Food Industries*, June 1941, p. 68.) The replacement of 20 to 25 percent of the sucrose ordinarily used in ice cream by corn syrup solids was found to affect but slightly the sweetness of the product and to improve somewhat the body and texture and melting characteristics of the ice cream. Consumer acceptance of ice cream containing sucrose and corn syrup solids seemed to be slightly greater than of that containing sucrose as the only sweetening agent. During the first part of the study it became evident that factors other than the sugar content of ice cream may affect the apparent sweetness of the product. Therefore, the project is being continued to study some of these factors.

Preliminary results indicate that the apparent sweetness of ice cream may be affected by such factors as the source of butterfat, the ratio of fat to serum solids,

the mineral salts present, and the melting characteristics of the product. Other factors are also involved, such as the serving temperature, the type of flavoring used, and the ratio of solids to sugar in the ice cream.

**A Study of New Stabilizing Materials for Ice Cream.** (M. J. Mack and A. M. Shipley.) Several new stabilizers have recently been developed and already are used to some extent in ice cream. The stabilizer employed affects a number of properties, such as the viscosity, titratable acidity, and whipping ability of the mix, and the flavor, body and texture, and melting properties of the ice cream. The object of this investigation is to compare the effectiveness of the new stabilizers with those already known to be desirable in ice cream.

Among six stabilizers thus far observed, two were as effective as gelatin or sodium alginate in producing mix viscosity and firmness of body in ice cream. They allowed satisfactory whipping of the mix and permitted normal melting of the product. The chief difficulty thus far encountered is that some of the newer stabilizers are somewhat lacking in solubility. The work will continue with a study of the effects of each active material employed, with the object of finding a combination of stabilizing materials more satisfactory than those now available.

**The Appearance of Melted Ice Cream.** (M. J. Mack.) The melting characteristics of ice cream have recently received more consideration, as is evidenced by the fact that the new score card approved for ice cream by the American Dairy Science Association allots 5 points to this item. Severe defects in melting appearance usually are due to loss of stability of the casein in the ice cream, while minor defects may be due to other causes.

Slight increases in the acidity of mixes cause ice cream to appear curdy or "whey off" when melting, if normal homogenization pressures are maintained. Standardization of the acidity by the addition of some suitable alkaline material does not injure the melting appearance in ice cream of average composition unless the original acidity is greater than approximately 0.24 percent. The melting characteristics are affected to a lesser degree by such factors as the components used, the percentage composition, the methods of freezing, and so on.

**A Comparison of the Electric and Vat Methods of Pasteurization.** (L. D. Lipman, J. H. Frandsen, and H. G. Lindquist.) Split batches of raw milk were pasteurized in an electric pasteurizer at 162° for 16 seconds, and in a spray vat at 143° for 30 minutes. The following conclusions may be drawn.

1. The reduction in vitamin C content of milk was less rapid in the electric-pasteurized milk than in raw or vat-pasteurized milks.

2. The electric method gave better, that is less, phosphatase units than the vat method.

3. Vat-pasteurization decreased the cream volume, while the electric method gave the same cream line as that of the raw milk. However, the difference between the two methods of pasteurization was so small that no definite conclusions should be drawn as to which of the two methods results in the smaller decrease in cream volume.

4. There was no significant difference in the efficiency of bacterial reduction between the vat and electric methods of pasteurization. With some milks the electric method seemed to show the higher percentage kill, whereas with other milks the vat method seemed to show the higher percentage kill. A probable explanation for this is that the types of bacteria or bacterial flora present in the milk will affect the percentage killed by pasteurization. For example, evidence seems to show that thermophilic bacteria are killed by the high-temperature-short-time pasteurization but survive and may grow at vat-pasteurization temperatures. The reverse seems to be true with the thermoduric types of bacteria.

5. Electric-pasteurized milk became oxidized less rapidly, less frequently, and to a lesser degree than did vat-pasteurized milk. A cooked flavor was found more often and more pronounced in vat-pasteurized milk than in electric-pasteurized milk.

6. Generally it can be said that electric pasteurization (high temperature-short time) of milk will tend to prevent development of oxidized and cooked flavors, and such milk will have a higher flavor score than vat-pasteurized milk at the end of 48 hours.

**A Study of the Efficiency of the McCormick-Deering Cream Separator (Standardizer.)** (A. M. Shipley and J. H. Frandsen.) In 1938 a report was given of a study of the suitability and practicability of the DeLaval Multipurpose Separator. In some further work on this project, tests have been made on the McCormick-Deering Cream Separator. The following results were obtained:

	Before	After
Sediment.....	9.8	9.8
Flavor Score.....	22.5	23.25
Fat (percent).....	3.0	4.0
Skim (percent).....	—	.01
Total solids (percent).....	11.395	12.35
Bacteria per c. c.....	1500	2400
Curd tension.....	60	57.5
Creaming (pint bottle).....	2 inches	2½ inches

Standardization, in addition to providing a milk of desired fat content, seems also to give milk of slightly better flavor. Standardization with a mechanical standardizer is, in our judgment, more practical and economical than standardization by siphoning or foremilkling.

**Some Factors Affecting the Wheying Off of Cultured Buttermilk.** (L. R. Glazier and H. G. Lindquist.) When cultured buttermilk is allowed to stand in storage, it frequently separates into a layer of curd and whey. In this study it was found that the higher the developed acidity, the less curd separation and wheying off occurred. Pasteurization at a temperature of 200° F. was more desirable for the milk to be used for culturing than was pasteurization at 180° F., and temperatures below 180° F. should be avoided. Storage temperatures as high as 50° F. should be avoided. Storage at 33° F. gave the best results of any of the temperatures used, in preventing wheying off of buttermilk in storage. The longer the buttermilk is held, the more separation and wheying off there is likely to be. Therefore, smaller batches should be made in order to eliminate long storage periods. (Published in *Milk Plant Monthly*, 30 (5): 27-30, 1941.)

## DEPARTMENT OF ECONOMICS

Alexander E. Cance in Charge

**Land-Use Problems in Massachusetts in Relation to a Balanced Program of Land Utilization.** (David Rozman.) The major phase of this project has been completed and the results presented for publication as Experiment Station Bulletin 387. This study deals with the interrelationship of major uses of land on a State and local basis. To an analysis of the historical trend in agricultural and forest land uses is added consideration of other important land uses such as recreational, part-time farming, residential, and industrial. The summary and main conclusions are as follows:



1. The classification of land on the basis of soil and topography indicates that 50.2 percent of the total area of the State is suitable for agricultural utilization.

2. The percentage of agricultural suitability varies from 31 percent in Barnstable County to 62.7 percent in Worcester County.

3. In 1880, before the decline in agricultural land use set in, 41.4 percent of the State area was represented by improved farm land. In 1940 this proportion had declined to 15.4 percent.

4. The major local land-use factors responsible for the decline of improved farm land relate in varying degrees to changing types and systems of farming; soil erosion and deterioration; non-resident land ownership; the disappearance of town industries; and the growth of residential, recreational, commercial, and other more intensive uses of land.

5. Non-resident ownership of about one-third of all land in rural towns has contributed to the increasing amount of land under wooded cover.

6. Of the total State area, 64.3 percent is under wooded cover. The highest proportion is in Barnstable and Berkshire counties, 73.1 and 71.8 percent, respectively; the lowest in Essex and Middlesex counties, 52.0 and 57.8 percent, respectively.

7. In the towns below 10,000 population there are 89 with no existing local industries. In each of 87 of the remaining 184 towns, local industries provide employment for less than 100 persons.

8. The demand for more intensive uses of land has affected farming through higher land values and taxes.

9. The average value per acre of farm land and buildings is \$37.38 in the lowest third of the towns below 10,000 population. In the highest third the average value is \$284.57 per acre.

10. From the standpoint of land-use pattern and land-use adjustments needed, five types of rural towns are indicated in Massachusetts:

- A. Towns characterized by predominantly poor land, declining population, limited amount of agricultural land utilization, and extensive areas under wooded cover.

*Major adjustments needed:* Extension of public ownership of forest land, elimination of isolated settlement, development of recreational facilities, possible discontinuation of the town as an independent political unit.

- B. Towns with a fair agricultural background, experiencing recent dislocation in local industries.

*Major adjustments needed:* Realignment of town expenditures, fuller utilization of land resources for agriculture and other uses, rehabilitation of industrial opportunities.

- C. Towns with favorable physical background for well-rounded agricultural land utilization.

*Major adjustments needed:* Conservation of soil, better adaptation of crops, and better care of woodlots.

- D. Towns with receding agricultural land utilization as a result of expansion in more intensive uses of land.

*Major adjustments needed:* Prevention of increase of idle land held for speculative purposes, primarily by more equitable taxation of land used in agriculture.

- E. Towns with a balanced system of agricultural and other land uses.

*Major adjustments needed:* Maintenance and improvement of local conditions through farsighted policies of local people and their planning agencies.



**Problems of Rural Youth in Massachusetts.** (David Rozman, Gilbert Mel-drum, Ruth E. Sherburne.) This study was undertaken during the past year in cooperation with the United States Department of Agriculture to determine and analyze the most important problems of rural youth in Massachusetts. Nearly 600 schedules were obtained in selected towns in four counties, including young people, both in school and out of school, ranging in age from 16 to 25. For 40 percent of the boys the main problem had to do with finding a job, making a living, or getting started in farming. For one-fourth of the girls the major problems were also economic. Of the problems mentioned by both boys and girls, 25 percent concerned education and vocational guidance.

The results of this study have been analyzed and presented as Experiment Station Bulletin 386.

## DEPARTMENT OF ENGINEERING

### C. I. Gunness in Charge

**Cranberry Storage Investigation.** (C. I. Gunness, H. J. Franklin, and C. R. Fellers.) The storage of Early Black cranberries in a modified atmosphere was continued during the 1941 season. All the berries were picked and stored on September 8 and removed from storage and screened on November 14. Three lots of berries were stored at 35 degrees and three lots at 45 degrees. One lot at each temperature was kept in normal atmosphere, one lot in an atmosphere containing 5 percent carbon dioxide and 2 percent oxygen, and one lot in an atmosphere containing 10 percent carbon dioxide and 10 percent oxygen. The berries stored in modified atmospheres were kept in sealed sheet iron cabinets having a capacity of 2 barrels each. Means were provided for removal of excess carbon dioxide by circulating the air from the cabinets through a solution of sodium-hydroxide. Excess moisture was removed from the cabinets by circulating the air through calcium chloride.

Apparently this process was ineffective as the berries were covered with moisture when the cabinets were opened at the end of the test.

Berries stored in normal air at 35 degrees and 45 degrees showed the usual differences in storage loss which have been observed in former years. Those stored at 35 degrees showed a storage loss of 4.7 percent, while those at 45 degrees showed a loss of 11.6 percent. All the berries stored in the modified atmospheres showed greater losses than those stored in normal air. It is not known, however, whether this increased loss was due to the composition of the atmosphere or to the excessive moisture in the cabinets. The experiment will have to be repeated next year with more efficient equipment for removing excess moisture from the cabinets.

Berries stored in normal air developed very much better color at 45 degrees than at 35 degrees. Berries stored in modified atmospheres on the other hand, developed no better color at 45 degrees than at 35 degrees; and berries stored in modified atmospheres at 35 degrees were not as well colored as those kept in normal air at 35 degrees.

**Apple Storage Investigation.** (C. I. Gunness in cooperation with Department of Pomology.) A small room for the storage of apples in a modified atmosphere was prepared during the summer of 1940 and filled with McIntosh apples that fall. The room had a small leak and it was not possible to reduce the oxygen content to the desired 2 percent. Considerable variation in temperature increased air circulation through the leak, and it was not possible to reduce the

oxygen below 11 percent. The results obtained with the storage were, therefore, unsatisfactory, the fruit on removal being in about the same condition as fruit kept at 32 degrees in a normal atmosphere.

During the past summer the leak was stopped and a new cooling unit installed with a sensitive thermostat. The room is now operating with an atmosphere of 5 percent carbon dioxide and 2 percent oxygen. Results will not be available until the room is opened in the spring.

**Frost Protection on Cranberry Bogs.** (C. I. Gunness.) The wind machine used for frost protection was moved to a dry bog in the spring of 1941. It was operated both in the spring and in the fall. The results were in general unsatisfactory in that protection was given over too small an area.

**Poultry House Investigation.** (C. I. Gunness and W. C. Sanctuary.) The investigation on the operation of electric brooders in colony houses was continued during 1941. The purpose of the investigation was to see whether litter could be kept dry in a brooder house through the use of soil heating cable. Very wet sawdust litter was placed in the houses and while the litter in the house equipped with soil cable was drier than in the others, it was not sufficiently dry to be considered satisfactory. It was felt, however, that the litter was too wet at the start to make a fair test of the effect of the soil cable. Good chicks were reared in spite of the damp litter conditions. The test is being repeated this year.

Ceiling temperatures were taken during the winter months of 1941 in insulated and non-insulated pens through the use of thermocouples. Ventilation was adjusted so as to keep the same temperature in insulated and uninsulated pens. It was found that on cold nights the ceiling temperatures in insulated pens would run one degree lower than air temperatures within the pen, while in uninsulated pens the ceiling temperature would run 4.5 degrees lower than the air temperature. This would indicate that insulated pens are more comfortable for the birds even though there may be but slight difference in air temperatures.

Observations taken during the late summer showed ceiling temperatures from 5 to 13 degrees higher in uninsulated pens than in insulated pens with equal air temperatures. In sections where the black composition roof had been painted with aluminum paint, the ceiling temperature in uninsulated pens was reduced from 85 degrees to 82 degrees on the rear slope when compared with sections which had not been painted. In insulated pens the aluminum paint produced a difference of 3 degrees in ceiling temperatures on the rear slope. On the front slope the black surface gave a ceiling temperature of 101 degrees in the uninsulated pens with a temperature of 92 under the aluminum paint. In the insulated pen the black gave 88 degrees and the aluminum 85 degrees on the front slope.

## DEPARTMENT OF ENTOMOLOGY

Charles P. Alexander in Charge

### Investigation of Materials which Promise Value in Insect Control.

*Oil sprays for dormant applications.* (A. I. Bourne and W. D. Whitcomb.) The early season of 1941 was unusual in many respects. March was characterized by cold, windy weather with the average temperature below normal and snowfall above the average. April, however, was marked by abnormally high temperature which persisted throughout the month and culminated in the peak of 90 degrees reached on the 20th. The transition from winter to spring was very

abrupt, and since it was not accompanied with the usual amount of rainfall the snow and frost disappeared rapidly and the soil dried quickly, furnishing excellent ground conditions for early spring spraying. Plant and animal life responded to the unusually warm weather. Seasonal development began early and progressed rapidly. In most orchards the period for delayed dormant application of oil sprays was very brief so that many growers were unable to complete this application before bud development progressed to the pre-pink stage. In the college orchards the delayed dormant period was passed in 4 to 5 days, and some blocks received the pre-pink spray 3 days after the delayed dormant. In the experimental blocks the trees had received the dormant, delayed dormant, pre-pink, and pink sprays by April 28 in contrast to 1940 when in the same blocks the delayed dormant spray was applied April 29. Very few instances of damage to fruit buds or foliage by oil sprays were observed or reported in spite of the unseasonable temperature. This was probably due in large measure to the relatively small amount of oil spraying done.

In the cooperative project with the Dow Chemical Company on the investigation of DN sprays, attention was focused on the relative tolerance of various types of ornamentals (coniferous and deciduous) to dormant applications of DN-oil sprays. In these tests different concentrations of dinitro-ortho-cyclo-hexylphenol (DNOCHP) compounds were used. None of the common deciduous ornamentals showed any ill effects from the application aside from a slight retardation in some cases. Moderate burning was noted on Irish juniper and more serious injury resulted on rhododendron and laurel.

In strictly dormant application on apples for the control of overwintering eggs of European red mite, 2 dry-mix DN compositions containing 40 percent DNOCHP and DNOC (dinitro-orthocresol) respectively were combined with 2 standard types of commercial oil sprays. Application of a DNOCHP--oil solution of 7.9 pH caused no injury to fruit or leaf buds nor retardation in development. A DNOCHP-oil solution of 6.6 pH caused noticeable retardation in development but no actual killing of buds. The DNOC-oil solutions of 5.8 pH and 4.8 pH both caused marked retardation of bud development. The combinations containing the DN compounds were somewhat less effective against red mite eggs than were the oils alone.

Counts of young mites on the test trees showed 1,660 mites per 100 spurs following DNOCHP-oil emulsion; 675 following DNOC-oil emulsion; and 465 following the oil emulsion alone. Check trees showed 13,055 mites per 100 spurs. Following DNOCHP+miscible oil, counts showed 20 mites, DNOC+miscible oil, 80 mites; and miscible oil alone, 15 mites per 100 spurs.

In applications at Waltham on April 8, 1941, no noticeable injury resulted to bark or twigs from DN-oil mixtures having a pH value of 8.0, 7.45, or 6.75. All of the mixtures retarded bud development slightly, and when trees were in full bloom there was slightly more retardation on McIntosh and Wealthy from the alkaline mixture than from the more acid mixture. It was also observed that a dinitro-orthocresol-oil mixture retarded bud development slightly less than dinitro-ortho-cyclo-hexylphenol in combination with either alkaline or acid oil emulsion.

All of the sprays gave good control of the European red mite eggs and reduced the average number of living mites per spur on April 30 by 90 percent or more. No significant differences between the materials resulted, but the dinitro-orthocresol-oil mixture, which is generally considered safer than the DNOCHP mixture, gave very satisfactory control of the red mite.

At the college, incidental records on the overwintering eggs of aphids, including heavy infestations on birch and pine and moderate infestations on several ornamentals, showed practically perfect kill following the use of DN compounds.



The contrast between sprayed and unsprayed specimens of *Viburnum* was conspicuous. (See page 54.) The foliage of unsprayed checks was tightly curled and distorted and the plants were of little use as ornamentals, while on the sprayed plants freedom from aphid attack allowed full and perfect foliage, a condition that is rarely seen in this region.

Dormant application of a commercial oil emulsion at 5 percent dilution combined with dry-mix DNOCHP gave excellent control of oystershell scale on lilac and willow. Light to moderate infestations were eliminated. On heavy infestations with thick encrustation of the bark, some slight hatching took place but from a commercial standpoint it was negligible.

*Summer Treatments for the Control of European Red Mite.* (A. I. Bourne and W. D. Whitcomb.) Another abnormal feature of a very unusual season was the comparative scarcity of European red mite in most orchards in midsummer and late summer. The infestation was negligible in the college orchard. A heavy outbreak in a Berkshire County orchard offered opportunity for checking the efficiency of a DN dust (a 1.7 dicyclohexylamine salt of DNOCHP). The red mite population before dusting amounted to 54.8 mites per leaf. Counts 24 hours after treatment showed an average of 9.6 mites per leaf, and similar counts made 8 to 9 days after treatment showed an average of one mite per leaf—an 82.5 percent reduction in 24 hours and a 98.1 percent reduction after an 8- to 9-day period.

Tolerance tests of this dust and of a DN spray containing 20 percent of the toxicant designed for summer use, on 28 different types of fruit and shade trees, ornamentals, and garden plants subject to mite attack showed no injury following either the dust or the spray.

In August, tests of new materials for the control of the European red mite on apple were made both at a commercial orchard in Gleasondale and at the Waltham Field Station. The most effective material was a dicyclohexylamine salt of dinitro-ortho-cyclo-hexylphenol mixture containing 20 percent of the toxicant together with dispersing and wetting agent. In four tests of this material at the rate of 20, 24, and 30 ounces in 100 gallons of spray, the average reduction of living red mites was 94.2 percent. There was no significant difference between the dosages used, indicating that the smallest amount (20 ounces in 100 gallons) was adequate. A 40 percent DNOCHP mixture used at 4 ounces in 100 gallons gave 88.1 percent reduction and apparently lacked sufficient wetting agent. A DN dust containing 1.5 percent of the toxicant averaged 95.3 percent reduction when applied from both sides of the tree and reduced the living mites 89.3 percent when the tree was dusted from one side only.

Five tests of spray materials containing rotenone averaged 88.5 percent reduction, including one moderately effective combination which gave only 78.7 percent reduction. A pyrethrum spray containing an excellent spreading agent was one of the most effective materials used and reduced an infestation of 20.04 red mites per leaf to 0.69 live mites per leaf, a control of 97.05 percent. A mixture containing ricin, the toxic ingredient in castor-bean, was the least effective material used. None of the materials caused injury to the fruit, bark, or foliage which was abnormally "hard" following the summer drought.



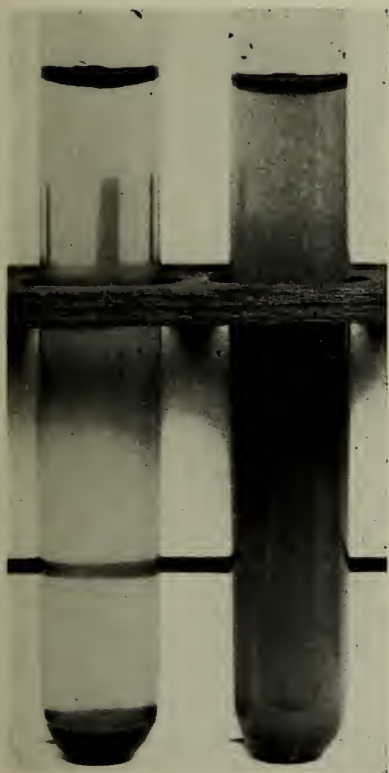


Figure 1

Left: Merrimac fine sandy loam.

Right: Memphis silt loam.

Equal weights of soil dispersed in equal amounts of water and allowed to settle the same length of time.

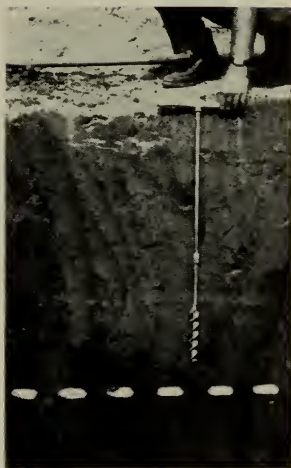


Figure 2

Topsoil 3.5 feet deep, accumulated at the foot of a short cultivated slope through the action of sheet erosion. (Broken white line separates topsoil and subsoil.)



*Viburnum*

Upper Branch Untreated: Leaves tightly curled, twigs deformed.

Lower Branch Sprayed with DN: Free from aphids, leaves normal.



Defoliation of Rose by the Common Red Spider

Plant at left sprayed

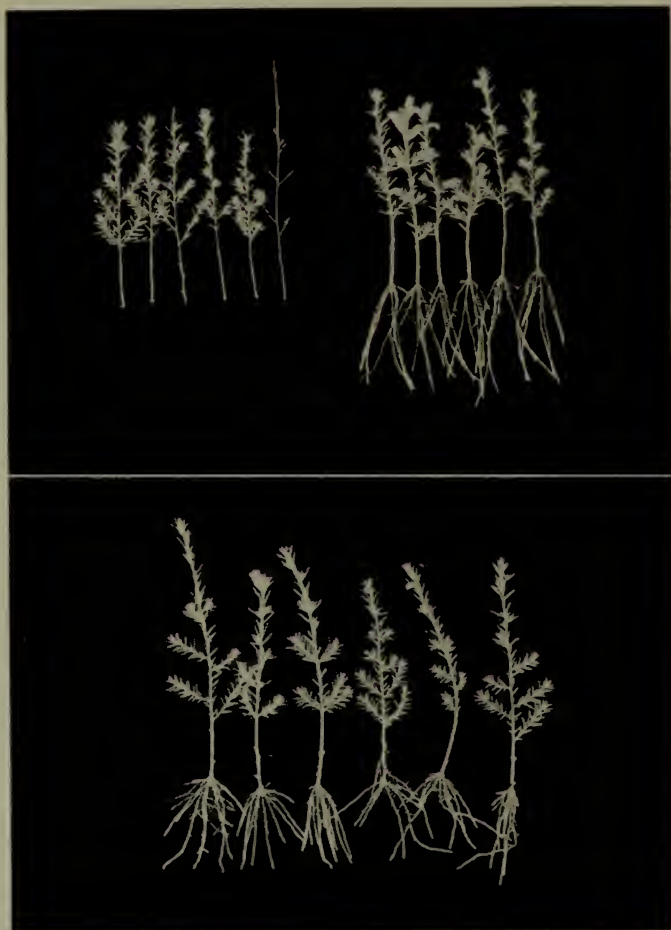
Plant at right unsprayed



Injury to Ears of Sweet Corn from Oil—Pyrethrum  
applied for control of Corn Ear Worm

Left: Not treated

Right: Treated



Rooting of Cuttings of Canadian Hemlock

Top: After 10 weeks at 75° F.

Left: Not treated.

Right: Treated with Hormodin A, 30 BTI units for 24 hours.

Bottom: After 15 weeks at 65° F.

Treated with Indolebutyric Acid, 7.5 mg. / 100 c. c. for 24 hours.



*Summer Sprays for Apples.* (A. I. Bourne in cooperation with Departments of Pomology and Botany.) Studies of the value of modifications of the standard spray program were continued. The yield was light, and the prolonged drought in the early season greatly influenced the prevalence of disease, particularly apple scab. The standard spray program, involving lime-sulfur in all sprays through the calyx with wettable sulfur thereafter, was contrasted with a similar program with the addition of a midbloom application of wettable sulfur, and an optional standard in which no lime was used in the cover sprays. The standard schedule was also contrasted with a program of wettable sulfur throughout the season. Lead arsenate was used in all applications except the pre-pink and midbloom sprays. The dosage was 4 pounds to 100 gallons in the calyx, and 1st and 2d cover sprays; 3 pounds in the pink and 3d cover sprays, and 2 pounds in the 4th cover spray. Liquid lime-sulfur was used at the rate of  $1\frac{1}{2}$  gallons per 100 and wettable sulfur at 8 pounds per 100 gallons.

The pathologist reported that scab infection was appearing on the foliage of McIntosh check trees in the period of May 23 to 26, and a few infected fruits were observed May 31. On the sprayed trees the spur leaves and fruits were evidently protected by the pre-blossom sprays and the infection was confined to the shoot leaves. The record of McIntosh fruit at harvest supported these observations. The fruit from unsprayed trees showed 44 to 45 percent scab, while on sprayed trees it varied from 0 to 1.8 percent.

The season also was not conducive to spray injury on either leaves or fruit. Distinct injury, however, occurred in all plots where liquid lime-sulfur was applied although this was not of so serious a nature or extent as in years of more normal rainfall. Russetting of fruit was noted in all plots where lime-sulfur was applied.

The control of insect pests was consistent throughout the entire orchard and there was no significant difference between the standard program and the modified schedules. The record of unsprayed McIntosh fruit was illuminating. Three apples, or 0.6 percent were clean; 80 to 81 percent of the fruit was scarred by curculio, and nearly 50 percent damaged by codling moth. Scab occurred on 44 to 45 percent of the apples (in a season very unfavorable for its development). Detailed counts showed that on nearly 50 percent of the fruit there were injuries by three or more insects or diseases on the same apple.

**Control of Cabbage Maggot.** (W. D. Whitcomb, Waltham.) Definite information showing that one of the largest sources of cabbage maggot flies in the spring is late-planted cruciferous crops was obtained by sifting the soil in a six-inch square and six inches deep around roots of cabbage, broccoli, and turnip which had remained in the ground over winter. These plants were apparently infested by a third generation of the maggot in September. Soil examination on April 18, 1941, showed a maximum of 51 pupae per plant, with an average of 19.9, on a small planting of yellow turnip; a maximum of 14 per plant with an average of 4.9, on a small planting of broccoli; and a maximum of 11 per plant, with an average of 1.9, on a large planting of cabbage.

The first eggs of the cabbage maggot in the spring of 1941 were found on May 1, which is five days earlier than the average date for the past ten years. The normal field infestation was 85.72 percent commercial injury on the Golden Acre variety. One application of corrosive sublimate solution on May 3 gave 92.04 percent commercial protection and yielded 78 percent large and medium heads. Two applications of corrosive sublimate solution gave 96.67 percent commercial protection and yielded 83 percent large and medium heads. Calomel-talc powder containing 4 percent calomel applied at the rate of a teaspoonful around the stem of each plant on May 3 was also satisfactory, giving 100 percent commercial protection and yielding 75 percent large and medium heads.

In 1941 twelve varieties of cabbage were planted to determine their natural susceptibility to cabbage maggot injury. The results indicated that the early maturing varieties such as Golden Acre and the Savoy types were most susceptible, and the red varieties most resistant. Dry weather in the latter part of the growing season interfered with the records on head development, but Red Acre with 64.83 percent large and medium heads withstood the maggot injury and drought the best, while Golden Acre, which suffered the most maggot injury, gave the poorest yield with 7.69 percent marketable heads.

*Susceptibility of Cabbage Varieties to Cabbage Maggot Injury, Waltham, Mass., 1941.*

*Very Susceptible* (80 percent or more commercial injury).—Golden Acre, Enkhuizen Glory.

*Susceptible* (65 to 80 percent commercial injury).—Super Curled Savoy, Cornell Early Savoy.

*Moderately Susceptible* (40 to 65 percent commercial injury).—Premium Flat Dutch, All Head Early, Danish Drumhead, Early Jersey Wakefield, Penn State Ballhead.

*Slightly Resistant* (25 to 40 percent commercial injury).—Mammoth Red Rock, Red Drumhead, Red Acre.

**Control of the Squash Vine Borer.** (W. D. Whitcomb, Waltham.) The field infestation of the squash vine borer was 7.52 borers per vine, which is one of the greatest infestations ever recorded in the experimental field of Blue Hubbard squash at Waltham. Experimental sprays and dusts were applied July 7, 14, 21, and 28. The sprays were applied at 275 pounds pressure with a small power sprayer, and the dusts with a plunger type hand duster. The most effective treatments were a rotenone-copper oxychloride sulfate dust, white oil emulsion 1 percent with nicotine sulfate 1-500 spray, and nicotine sulfate 1-250 spray. Rotenone-talc dust containing 0.75 percent rotenone and a dust containing 20 percent cryolite with 5 percent metallic copper were moderately effective. Lead arsenate 3 pounds with fish oil 1 pint in 100 gallons of water as a spray was ineffective, this plot having an infestation only 12 percent less than the untreated check.

Yield records showed a significant increase in favor of the dusted plants, reflecting the beneficial action of a fungicide on the production of fruit. The plants receiving the rotenone-copper oxychloride sulfate dust yielded 594 pounds more than the untreated check, an increase of 80 percent. As in previous experiments, there was no consistent direct correlation between yield and borer injury. The 1941 experiments also strengthened the theory that an infestation of 2 borers or less per vine before August 1 does not greatly reduce the yield.

**Control of Onion Thrips.** (A. I. Bourne.) The early spring was characterized by abnormally warm weather in April and was followed by more normal temperatures in May with very little rain during that period. This was followed by weather somewhat warmer than normal in June and rains which, although for the most part small in amount, were so frequent that field crops such as onions made an early start and grew rapidly.

Such weather conditions would normally favor the early appearance and rapid development of thrips but this was not the case in 1941. In the experimental plots of seed onions, thrips appeared late and developed slowly. There were practically no thrips on the plants throughout June, and by July 14 the average population per plant was only 10 thrips. Very high temperature in early July induced a rapid increase to the peak of 40 thrips per plant on July 21. Following a rainfall of nearly one-half inch on the 25th and a heavy downpour during the 28th (1.9 inches) the number of thrips was reduced to approximately 12 per

plant and remained at that low level until late August when the plants matured. No blast was observed.

Throughout the Valley, fields of both set and seed-grown onions were comparatively free from thrips. Results of tests of contact insecticides for thrips control were inconclusive because of the scarcity of the insects even on the unsprayed plants. Fixed nicotine with a resin residue spreader gave good initial control although its action was slower than that of nicotine sulfate. It was as effective alone as when used with a spreader. A rotenone extract with resin residue spreader had a high immediate effect and good residual action. Derris powder (4 percent rotenone) gave excellent kill within 24 hours, and reinfestation was slow. This was true regardless of the type of spreader used. Nicotine sulfate and soap caused the usual high mortality of thrips within a few hours after application but its residual effect was inferior to that of rotenone.

Predaceous insects were comparatively scarce during the early summer, but by mid-August syrphid flies and predaceous thrips had increased to considerable numbers and contributed very greatly to the rapid decline, in late August, of a very light but long-drawn-out attack of thrips. No evidence of fungus disease of thrips was observed.

**The Spray Residue Problem.** (A. I. Bourne.) The more liberal limits of tolerance established in the late summer of 1940 continued in effect for the shipping season of 1941. While the present limits are calculated to allow the growers greater latitude in their pest control program, the prolonged drought from late July until harvest and the uncertainty as to the permanency of the present limits made growers reluctant to enlarge their spray program, and for the most part very few changes were made. In the spray program recommended by the college for 1941 the only significant change was the suggestion of a 75-25 sulfur-lead arsenate dust as an alternate for the 2d cover spray.

Through the cooperation of the Control Service, analyses were made for lead and arsenic residue on samples of McIntosh collected from the sprayed plots at harvest. These analyses showed the amount of residue to be in all cases well below the present limits.

Fruit which had received the standard schedule recommended for the State showed residues of .031 grains of lead and .013 grains of arsenic per pound of fruit. Samples from the optional standard schedule in which no lime was used in the cover sprays gave .026 grains of lead and .009 grains of arsenic per pound. In the plots where wettable sulfur was used throughout the season, the lead residue ranged from .023 to .037 grains per pound and the arsenic residue from .005 to .015 grains. Lead arsenate was applied in the 2d cover spray (June 10) at 4 pounds per 100 gallons; 3 pounds in the 3d cover (July 2); and 2 pounds in the 4th cover (July 29). The fruit was picked September 15. While the total precipitation for July was nearly normal, approximately half of it occurred in one shower on the 28th. Records showed that during August and September little more than half the normal rainfall occurred, a deficiency of 3.67 inches. Fruit encountered unusually favorable conditions for the retention of spray deposits and normal weathering off could not take place.

Even under such a severe test as the past season offered, lead and arsenic residues were so far below present limits that there was a substantial margin of safety, which would indicate that if these limits are retained the growers will have more latitude for stiffening their spray schedule for late summer pests than they have enjoyed since spray residues became a problem of major importance.

**Apple Maggot Control.** (A. I. Bourne and W. D. Whitcomb.) Apple maggot proved to be of relatively minor importance in 1941, not only in Massachusetts but throughout most of the Northeastern States. In well-sprayed commercial



orchards the injury was negligible, and even in the smaller home orchards which received little attention the pest was not conspicuous.

This reduction is not believed to be due to any marked increase in energy on the part of the growers or to any improvement in the handling of dropped fruit or other precautionary measures. It is the general belief that adverse weather conditions and especially deficient rainfall at the period of normal emergence of the flies were the chief contributing factors.

In the emergence cages at Waltham the flies began to appear on June 19 which is the earliest date since the observations were started. Although the cages were operated in the same way as in the previous years, the emergence in the cultivated cage was greater than usual and that in the sod much smaller than usual. This condition is apparently correlated with the deficiency of soil moisture this year. The emergence record is as follows:

	In Sun — Light Soil	
	Cultivated	Sod
Degree of Emergence:		
First fly.....	June 19	June 24
25%.....	June 30	July 3
50%.....	July 7	July 9
75%.....	July 12	July 15
100%.....	August 7	July 27
Number of larvae in 1940.....	400	400
Number of flies emerged 1941.....	207	43
Percent emergence.....	51.75	10.75

**Insecticides for the Control of European Corn Borer.** (A. I. Bourne and W. D. Whitcomb.) The unseasonably warm weather throughout April promoted abnormally early pupation of the overwintering corn borer larvae. Seasonable weather in May allowed development to progress normally and resulted in a very early emergence of the spring brood of moths. On the other hand most of the growers planted corn at the usual time, with the result that considerable moth emergence took place before corn was above ground or at least when it was too small to be attractive for oviposition. In addition, during much of the time that the moths were present the temperatures at dusk were too low for moth activity. As a result the infestation by first generation larvae was negligible throughout the State. Growers harvested very clean corn even where no control measures were practiced, and in fields which were sprayed or dusted there was slight evidence of the borer.

In the experimental fields the plots sprayed with derris and Ultrawet showed 4 infested ears out of 660, 99.4 percent clean corn, 84.5 percent of which was grade 1 or 2; in other words, 84 percent of the total yield was marketable grade. A fixed-nicotine spray gave 97.1 percent clean corn, 84 percent of which was marketable. In the plots dusted with derris there were 4 infested ears in a total of 652, 99.4 percent clean corn, 90 percent of which was of marketable grade. Dual-fixed nicotine dust gave 98.8 percent clean ears, and 84 percent of the total yield was of marketable grade. The infested ears were so few that the grower made no effort to salvage them. The unsprayed check plots yielded a total of 682 ears, 48 of which were infested. In other words the infestation was so light that 92.9 percent of the yield was free from borers. In the entire field, regardless of treatment, only 83 ears out of 3,341 examined were infested. No attempt was made to spray late corn because of the scarcity of 2d brood larvae.

The infestation by the first generation of the European corn borer in the experimental planting at Waltham was so light that results of spray applications



were not significant. In the check plot there were 5 infested non-salable ears and 5 infested but salable ears in a yield of 203 ears. Hills sprayed individually with a mist nozzle showed 1 infested but salable ear in 219 ears, and the block sprayed with a spray gun from the border showed 2 infested salable and 2 infested non-salable ears out of 226. Powdered derris root 3 pounds and Ultrawet  $\frac{1}{2}$  pound in 100 gallons was used June 17, 24, 30, and July 7.

The second generation planting at Waltham was not sprayed because of the light infestation, and an examination on August 21 showed 15 infested ears or 1.34 percent in 1,118 ears examined.

On August 12 a part of this corn was treated for protection against the corn ear worm, by applying a standard lubricating oil-pyrethrum solution to the dried silk of the ears. No corn ear worm infestation developed but the treatment injured the ears by preventing pollination of the kernels in the terminal portion of the ear, indicating that this treatment is not satisfactory under all conditions. (See page 55.)

**Potato Spraying Experiments.** (A. I. Bourne.) The weather conditions during spring and early summer furnished a very favorable start for potatoes and allowed them to keep this initial advantage. The plots were planted on May 9. The plants appeared promptly and growth was steady and rapid throughout the summer. The plants were slightly damaged by a light frost on the night of September 19-20 and were killed by a heavy frost on September 29-30. The crop was dug September 30 to October 2. In all of the plots sprayed with bordeaux the plants were alive, green, and thrifty until killed by frost.

Leafhoppers were very few and no outbreak occurred at any time during the season. Potato aphids became abundant in early July but were controlled by the addition of nicotine in the spray of July 16 and never threatened thereafter. Flea beetles were abundant throughout June and early July; the late July infestation was not so heavy. In the experimental plots 11 applications were made between June 11 and August 27. A new method of determining flea beetle injury was devised by which the number of feeding punctures was correlated with the amount of leaf growth. The plan was designed to show the amount of injury from week to week as well as the cumulative damage throughout the season. On this basis the amount of flea beetle feeding in the plots given a commercial spray of basic copper sulfate and sulfur was 103.1 feeding punctures per square inch of leaf surface; plots which received a basic copper arsenate-sulfur compound showed 45.1 feeding punctures per square inch of leaf surface; and the plot which received a neutral insoluble copper fungicide (double copper) showed 88.6 punctures per square inch.

In all the plots sprayed with home-made bordeaux mixture the damage from flea beetle feeding was very much less than that in the plots receiving commercial sprays. There was a slight advantage in favor of the low-calcium bordeaux, and the addition of calcium arsenate in every case furnished added protection.

The length of life of the plants in the different plots was in exact proportion to this index of beetle activity. The plants sprayed with basic copper sulfate and sulfur began to die early in August and by the end of the month practically all were dead. Plants in the plot given the basic copper arsenate-sulfur compound succumbed somewhat later. The plants given the neutral copper fungicide remained alive until mid-September. In all of the bordeaux-sprayed plots most of the plants were alive and green until the frosts of late September.

The summer was marked by a prolonged drought, and the lack of sufficient moisture interfered very seriously with the growth of the tubers and yields were proportionally reduced.

The yield records, however, showed a direct correlation with the amount of flea beetle injury. In the plots which received the commercial sprays, yields

of 308 to 346 bushels per acre were recorded, while plots in the same field which received bordeaux mixture yielded 420 bushels per acre. The plot which received the low-calcium bordeaux plus calcium arsenate gave the highest yield—474 bushes per acre, 76 percent of which was of number 1 grade.

**Introduction of Parasites of Oriental Fruit Moth in Peach Orchards.** (A. I. Bourne.) The work of rearing parasites of the oriental fruit moth was continued in 1941. By agreement with the Department of Entomology of the Connecticut Experiment Station, Mr. A. DeCaprio was again placed in charge of the collection and shipment of breeding material for both institutions. Parasitism was comparatively high in the New Jersey strawberry fields in 1941 and the season was early. Mr. DeCaprio, by benefit of his experience in past seasons, was able to locate superb fields for collection. Cool weather during the shipping period and rapid transit allowed the material to arrive at the laboratory in Amherst in very good condition.

The strawberry leaf roller larvae were very nearly full grown when collected so that very little migration took place after arrival in the laboratory. Emergence of the parasites was such that all the orders from growers were filled by June 30, and within the next few days a sufficient number of parasites emerged to duplicate all original orders, fill late orders, and in most cases duplicate these. The surplus material for distribution was made possible by the very proficient work of Mr. DeCaprio in collecting breeding material, the very accurate estimates of parasitism, and the improved technique in the laboratory. Fifty-eight growers in 9 counties received a total of 140 colonies. More than half the growers received their orders in half colonies to facilitate more uniform distribution in large orchards or for use in small, isolated blocks.

The warm weather, the unusually large number of hours of bright sunshine, and the few rainy days during the period of liberation offered very favorable weather conditions for the parasites.

**Naphthalene and Similar Compounds as Greenhouse Fumigants.** (W. D. Whitcomb and Wm. Garland, Waltham.) A complete series of experimental fumigations with a mixture of monochlor naphthalene oil 3 parts and commercial flake naphthalene 1 part indicated that the vaporization of  $\frac{3}{4}$  to 1 ounce of the fumigant in 1,000 cubic feet constitutes a lethal atmosphere which will kill 80 percent or more red spiders if they are exposed for three hours. These results were obtained when the experiment was made at a constant temperature of 70° F. and a relative humidity of 50 percent, and also at 75° F. and 60 percent humidity. At the higher temperature and humidity the mortality was about 3 percent higher, especially at the shorter exposures.

A mortality of 30 to 40 percent resulted when the spiders were exposed for three hours to  $\frac{1}{4}$  to  $\frac{1}{2}$  ounce per 1,000 cubic feet, and an exposure of one or two hours to a lethal atmosphere killed only 15 to 25 percent. Potted carnations heavily infested with the common red spider mite supplied the experimental material, and the fumigant was vaporized at the rate of  $\frac{1}{4}$  ounce per 1,000 cubic feet each hour for six hours. An infested plant was entered and removed each hour during the fumigation.

**Control of the Common Red Spider on Greenhouse Plants.** (W. D. Whitcomb, Wm. Garland, and W. E. Tomlinson, Jr., Waltham.) Life history studies of the red spider on different host plants at constant temperatures were continued. Most of the studies were on potted snapdragon and showed that the time required for development at 60°, 70° and 80° F. was approximately in a 3:2:1 ratio as follows:

	Average Number of Days at —		
	60° F.	70° F.	80° F.
From oviposition to hatching.....	14.48	7.71	3.81
From hatching to adult—male.....	15.70	9.46	5.35
female.....	19.17	11.00	6.25
From oviposition to adult—male.....	30.94	16.95	9.23
female.....	31.41	18.62	10.00

Oviposition records showed that although the female spiders laid about as many eggs at 60° F. as they laid at 70° and 80° F. in this experiment, they required about ten times as long to lay them.

Studies of red spider development on various host plants continue to indicate that there is some plant character which determines the rate of spider development, and studies to determine this are planned.

Spraying experiments with eleven advertised insecticides recommended for combating the red spider mites on roses were applied at weekly intervals in three series, using a greenhouse power sprayer at 275 pounds pressure. Of these, one material was very effective and outstanding; two were moderately effective and satisfactory; and eight were unsatisfactory. (See page 55.)

The most effective material is described as Technical Mannitan Monolaurate to which 1 percent rotenone and 1.8 and 2.6 percent other derris extractives have been added. When diluted to 1-400 this was the only spray material which reduced a natural infestation of 25 to 50 spiders per leaf to less than 5 live spiders per leaf, and consistently killed 90 percent or more of the spiders without injury to the plants. When diluted 1-600 this material was less effective but gave satisfactory control.

The other satisfactory materials, which combined rotenone and emulsified dispersing oils, reduced the infestation 60 to 80 percent and permitted 10-18 live spiders per leaf after treatment.

Unsatisfactory materials included rotenone combined with chlorinated heterocyclic hexylamine, powdered derris root and sulfonated castor oil, a commercial flour paste, monochlor naphthalene soap emulsion, a commercial preparation containing castor bean extract (ricin), and rotenone combined with hydrous aluminum oxide. Several of the rotenone sprays which gave unsatisfactory control of the red spider mite on roses gave excellent control of the same pest on potted carnations.

Three applications in March of a dinitro dust containing 1 percent dinitro-ortho-cyclo-hexylphenol killed 90 percent of the red spider mites and reduced an infestation from 25 to 2.4 live mites per leaf without injury to the foliage.

**Biology and Control of the Apple Leaf Curling Midge.** (W. D. Whitcomb, Waltham.) Although a strong northeast storm occurred on June 5 while the midge flies were still plentiful and might have been blown a considerable distance to the southwest, no new infestations outside of the previously known infested area were discovered or reported. However, this midge was found within the infested area in several orchards where it was not known to be present before 1941.

In the insectary the transformation to flies was 22.54 percent from maggots collected in June 1941, 45.41 percent from maggots collected in July and 11.11 percent from maggots collected in August.

In the observation orchard at Westford the infestation was very heavy during May and June but, because of the drought and absence of late summer growth even on watersprouts, it was below normal in late July and August. Records of 2117 bud tips on Baldwin trees examined at regular 3 and 4 day intervals between May 9 and September 12 showed that eggs were laid on 1712 or 80.87 percent of them. Oviposition was concentrated in three distinct periods when



eggs were found on every bud examined, namely May 27 to June 10, July 1 to 8, and July 22 to August 5. During the first two periods 100 tips were examined at each observation; but in the last period the number of tips available averaged less than 10, contrasted with 1940 when a large number of tips was available until about August 25. In 1941 the first eggs were found on May 9 which is 15 days earlier than in 1940.

Maturity of larvae and their emergence from rolled leaves was concentrated in three definite periods on June 17 to 24, July 8, and July 29. These periods generally correspond with the rainfall rather than with the development of generations which was extended and overlapped by abnormal weather conditions. The relative abundance of the midge throughout the summer is indicated by the number of larvae collected in 5 bands as follows: June 17, 2280; July 8, 244; and July 29, 790.

In a newly infested orchard at Waltham containing 96 trees of 7 varieties of approximate equal exposure to infestation, 893 infested buds were collected on June 12. The average number of infested tips per tree of each variety was: Delicious, 42.00; Rhode Island Greening, 8.75; Baldwin, 7.58; McIntosh, 4.54; Gravenstein, 3.16; Northern Spy, 0.33; and Wealthy, none. In this collection 63.29 percent of the infested tips were found on the Delicious trees. Another collection on July 9 yielded 532 infested tips on the same trees, making a reduction of 40.42 percent due to destruction of the maggots in the infested tips at the previous collection.

Similar collections from a nearby orchard where 396 infested tips were collected on 54 small trees showed an infestation of 11.94 tips per tree or 57.32 percent of the total on Starking; 6.00 per tree on Golden Delicious; and 3.58 per tree on Baldwin. In a block of young trees, 2 Milton trees had an average of 24.5 infested tips, indicating high susceptibility. At the same time no infested tips were found on 15 Macoun trees.

Continued experiments with naphthalene broadcasted at the rate of 2 pounds per 100 square feet showed that the treatment reduced the number of midge flies emerging from the soil and duff 79 percent at the first generation and 97 percent at the second generation.

Larvae and pupae in cocoons under the rough bark on the trunk of the trees were killed by experimental spraying with dormant sprays. Applications to the bark were made April 11 and July 1 using Elgetol (Standard Agricultural Chemical Company) 1 percent, Spra-Cream (B. G. Pratt Company) 3 percent actual oil, and Spra-Cream 3 percent plus DNOCHP (Dow Chemical Company) 15 ounces per 100 gallons. Cages enclosing 3 feet of the tree trunk were built around the sprayed trees. In these cages 84 flies of the first generation and 40 flies of the second generation were collected from the unsprayed tree, while only 2 flies were found in any of the cages on sprayed trees. Emergence of flies from mulch collected under trees where the above dormant sprays were applied at the rate of 2 gallons per 100 square feet indicated that considerable mortality of the midge resulted where Elgetol was applied but that the oil emulsion treatment was not effective.

**Control of Plum Curculio in Apples.** (W. D. Whitcomb, Waltham.) In spite of unseasonably warm weather during the pre-blossom and blossom period of apples, the critical period of curculio activity did not occur until May 20-23 which was five to eight days after the petal-fall stage. This period was characterized by maximum temperatures above 85° F., but it was apparent that the suitable development of the fruit for feeding and oviposition was the most important attraction to the beetles.

Blocks of eight trees each were sprayed with lead arsenate 4 pounds, wettable



sulfur 4 pounds, fish oil 1 pint in 100 gallons of water when the fruit was 4/16, 5/16, and 6/16 of an inch in diameter, as determined by the measurement of 200 apples with calipers.

Variety	Diameter of Apples		Date Sprayed	Apples Stung (Percent)
	Estimated (Inches)	Actual Average (Inches)		
Wealthy	$\frac{4}{16}$	$\frac{4.10}{16}$	May 20	18.72
	$\frac{5}{16}$	$\frac{5.10}{16}$	May 22	8.12
	$\frac{6}{16}$	$\frac{5.94}{16}$	May 23	18.70
McIntosh	$\frac{4}{16}$	$\frac{3.84}{16}$	May 20	11.53
	$\frac{5}{16}$	$\frac{4.99}{16}$	May 22	3.88
	$\frac{6}{16}$	$\frac{5.92}{16}$	May 23	5.42

These records, based on the examination of 57,835 apples, show least injury by the plum curculio to apples sprayed when they measured approximately 5/16 of an inch in diameter. This difference is the more significant since the "5/16" trees were located near a stone wall and fence row where much curculio injury has occurred in the past. In the Wealthy apples the curculio injury was 1 percent greater on dropped fruit than on picked fruit; but in McIntosh the dropped fruit showed 3 to 12 percent more injury.

**Biology and Control of the Grape Plume Moth and Grape Cane Girdler.** (W. D. Whitcomb and Wm. E. Tomlinson, Jr., Waltham)

*Grape Plume Moth.* A study of the parasitism of the grape plume moth yielded two new species (undetermined), but the total parasitism in the larvae collected was less than 1 percent.

The application of dormant sprays on April 10, just before the larvae hatched, showed that dinitro compounds are more effective than oil emulsion. In one experiment the addition of a DNOCHP compound at the rate of 15 ounces in 100 gallons increased the control from 74 to 86 percent over oil emulsion at the rate of 3 percent actual oil; and in another experiment the addition of DNOC (15 ounces-100 gallons) to 3 percent oil emulsion increased control from 60 to 82 percent. The best control was obtained with a commercial sodium dinitro cresylate 1 percent which gave 94 percent protection. When this material was used at  $\frac{1}{2}$  percent dilution the infestation was 12 percent or twice that following the use of the 1 percent dilution.

*Grape Cane Girdler.* The first activity of the grape cane girdler was observed on May 22 when the maximum temperature was 89° F. The average life of 26 individuals from egg deposition to adult in bagged canes in the vineyard was 60.8 days with most of the beetles emerging from August 15 to 25 but continuing until September 22.

In the vineyard, beetles were reared from 28 percent of the girdled canes under observation and this seemed to be a normal survival under the conditions.

Measurement of 100 canes showed that the average growth from May 22 to July 2 was approximately 1 inch per day, with Niagara and Fredonia making the most rapid growth and Delaware the least.

Sprays applied when the average cane growth was 4 inches or less prevented most girdling, but when the growth between sprays was about 8 inches the number of girdled canes was 8 to 15 percent greater than on the unsprayed vines. Cryolite at the rate of 3 pounds in 100 gallons was more satisfactory than lead arsenate, which caused some foliage injury when combined with sulfur or copper oxide in frequent applications.

#### **Insects Concerned in the Dispersal of Dutch Elm Disease. (W. B. Becker.)**

*The Smaller European Elm Bark Beetle, Scolytus multistriatus* Marsham. Elm logs in Alford, reported by the owner to have been cut just prior to April 1941, were found to contain only large larvae of *Scolytus multistriatus* at the end of September. No emergence holes could be found. If the time of cutting was given correctly, the size of the larvae present would suggest that one generation a year may be common in this region of the Berkshires. Logs of both American elm, *Ulmus americana* L., and slippery elm, *Ulmus fulva* Michx., were heavily infested. In an adjacent area, elm logs reported by the owner to have been cut at various times from the early spring through late fall of 1941 showed the presence of brood galleries in all stages of construction. Completed brood galleries containing large larvae, galleries with small larvae, and incomplete galleries with only eggs and active parent beetles were found.

*The Native Elm Bark Beetle, Hylurgopinus rufipes* (Eich.). At the end of September 1941, other elm logs in Alford which were reported by the owner to have been cut just prior to April 1941 contained larvae, pupae, and young adults of *H. rufipes* and many emergence holes. These logs were adjacent to those cut at the same time which were infested with *S. multistriatus*. The evidence suggests that in this vicinity *H. rufipes* beetles which develop from the first eggs laid in the spring may complete their development sooner than *S. multistriatus* beetles.

**Insects Observed in the First Tree in Massachusetts Found to have Dutch Elm Disease. (W. B. Becker.)** Numerous feeding or overwintering tunnels of *H. rufipes* were observed in the tree, especially near the base. Adult beetles were active in these tunnels in mid-September. Such tunnels, of course, are commonly encountered in live elm trees. No correlation was determined between the occurrence of these tunnels and the presence of the fungus, *Ceratostomella ulmi* (Schwarz) Buisman, in any part of the tree.

**Scouting for Elm Bark Beetles. (W. B. Becker.)** Brief scouting revealed the presence of *Scolytus multistriatus* at three locations new to this office: Concord, Alford, and Hancock, Mass.

At Alford, in the vicinity of the first tree in Massachusetts found to have Dutch elm disease, this beetle was abundant in elm logs on an area being cut over for cordwood. *Hylurgopinus rufipes* was also abundant in the vicinity of the diseased tree.

**The Effects of Solar Heat on the Subcortical Development of the Native Elm Bark Beetle, Hylurgopinus rufipes (Eich.) at Amherst. (W. B. Becker.)** Laboratory and field work on this problem was continued.

**Insect Pests of Wood and Shade, Forest, and Ornamental Trees in Massachusetts. (W. B. Becker.)** Three hundred and one inquiries were received about such insect pests. Eighty-four different kinds of insects were involved. Ants, powder post beetles, termites, spruce gall aphids, elm leaf beetles, and secondary tree-boring insects were received most frequently.

## DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

**Breeding Snapdragons for Varietal Improvement and Disease Resistance.** (Harold E. White, Waltham.) Plants propagated vegetatively from Field Station rust-resistant strains of commercial hybrid snapdragons have been tested two summers under field conditions and in the greenhouse for two winters. These strains were highly resistant to rust disease; a wide range of flower colors was present, and growth and flowering habit were excellent. Many of these hybrids are still segregating for rust susceptibility and are heterozygous for flower color.

A few selections from seeded lines look promising as material for developing pure breeding forms for rust resistance and desirable flower colors. In earlier breeding work with Main's hybrids considerable difficulty was experienced in getting rust resistance bred into such selections and at the same time retaining desirable flower colors, growth habits, and blooming period in the same strains. It was anticipated that with the commercial variety hybrids this combination might be more readily developed into desirable pure-bred lines.

These hybrids are available now, provided florists are interested in growing snapdragons by propagating such strains from cuttings.

**Cultural Requirements of Freesia.** (Harold E. White, Waltham.) Records on the pre-curing or drying of freesia corms ( $\frac{5}{8}$  to  $\frac{3}{4}$  inch size), for a period of 3 to 11 weeks prior to planting, show that by this treatment in 1939 corms lost from 3 to 24 percent of their weight; in 1940, 3 to 20 percent; and in 1941, 7 to 21 percent. Corms of Golden Daffodil ( $\frac{5}{8}$  to  $\frac{3}{4}$  inch) in the 1940 treatment failed to sprout unless pre-cured for 3 weeks prior to planting. Corms of this variety received the same pre-curing treatment in 1941 but responded normally, which would indicate that, although the pre-curing treatments of the corms in 1940 overcame the growth inhibition factor, this same peculiarity was not present in the 1941 stock.

Loss in moisture content of freesia corms through pre-curing treatments has not been found to have any significant effect on the blooming or production characteristics of the corms. At a temperature of 48°-50° F., corms grown in benches flowered a week to ten days earlier than those grown in bulb pans. Early and later planted corms in bulb pans, shifted in November from a temperature of 50° F. to 60°F., flowered two weeks earlier on an average than those continued at the cooler temperature.

Results of tests in pre-curing freesia corms for periods of 2 to 11 weeks prior to forcing indicate that such treatments are not essential for successful forcing of freesias in the greenhouse. It is concluded that seasonal and cultural treatments given the freesia corms in the field are more likely to determine their forcing performance.

The use of well-rotted manure in soil mixtures for freesias has not had any harmful effect on the growth or flowering of the corms.

Foliage tip-burn of freesia plants may be caused by fumigants and by fluctuations in temperature, soil moisture, and humidity. Contrary to general opinion, freesias will take plenty of water when well rooted in properly drained soil and growing normally.

Elder's Giant White was observed to be a much slower growing type than Purity, Golden Wonder, or Golden Daffodil.

**Soilless Culture of Florists' Crops.** (Harold E. White, Waltham.) This system of plant culture has been conducted primarily as a demonstration for growers and to determine how much attention must be given to such a system to obtain crop production comparable to results from soil culture.

Carnation plants have responded equally well to some four to six nutrient formulas which have been tested. It is apparent, at least with carnations, that a considerable degree of adaptability to nutritional levels exists under soilless culture conditions, which is likewise true for plants grown in soil.

Root rot and stem diseases of carnations can be just as prevalent and destructive under gravel culture methods as in soil, particularly soon after the plants are set. Much of the danger lies in keeping the plants too wet rather than too dry. Tobacco and naphthalene fumigants can be used on carnations in gravel, following the same precautions necessary for successful fumigation of plants in soil.

New England growers have shown little inclination to grow flower crops in gravel, even on a trial basis. One grower, who last year was favorably impressed with the results from 350 square feet of soilless roses, has expanded to 2,500 square feet. At Waltham cinders, which for two years were used in growing roses, are now being used for the culture of carnations.

**Liming Carnation Soils.** (Harold E. White, Waltham.) Data for two years on the use of lime on carnation soils to determine the importance of soil acidity as related to plant growth and flower production show that carnations have a wide degree of adaptability to changes in soil acidity. The average acidity test of soil used for carnations was pH 5.6; the final acidity readings over a period of two years were 4.7 for unlimed and 6.4 for highly limed soils. While this test does not cover extreme ranges in acidity or alkalinity, it does pertain to normal variations of growers' soils as observed from soil testing records of five years at the Waltham Field Station.

There were no significant differences in flower production, number of split calyces, or vegetative plant growth between plants in unlimed soil and those in soil receiving applications of lime at the rate of 1 to 3 tons per acre.

Plants of the variety Ward were used in these tests and the same cultural treatments were given both years. Cultural and seasonal climatic conditions were of greater importance than soil treatments in their effect on crop production. The greater incidence of split calyces occurred between the months of January and April. During the season of 1940-41 plants produced only 2 percent more split calyces than during the previous season.

Field-grown plants produced four more flowers per square foot of bench area than greenhouse-grown plants. Since liming of soils had no perceptible effect on prevalence of root or stem rot diseases, the common practice of applying lime to correct or inhibit the spread of these soil organisms may be considered of little value for the purpose.

**Disease Resistance and Heredity of Carnations.** (Harold E. White, Waltham.) This work is merely getting under way. Thirty-five varieties have been assembled for study. The sowing of different varieties and experiments in germination of pollen are in progress.

In some preliminary breeding work in 1939-1940 a cross between the varieties Ward (pink) and Puritan (white) gave a progeny of 45.83 percent white flowers, 36.45 percent pink, 2 percent red, and 15.62 percent variegated flowers. The flower types were 8.24 percent singles, 56.70 percent commercial (normal) doubles, and 35.05 percent bursters or split calyx types. Short-calyx flowers were dominant over long or intermediate types. Broad-leaved characters of plants were dominant over narrow and medium leaf characters. These observations show, as was expected, that the commercial types of carnations are heterozygous for many of the plant characters to be studied in this project.

**Coffee Chaff as a Soil Amendment.** (Harold E. White, Waltham.) Inquiries are frequently received from manufacturing concerns as to the possible use in



greenhouse soils of certain waste organic by-products; when convenient, these materials are tested on the current-year crops at the Field Station.

Coffee chaff received from Wetmore and Company, Cambridge, Mass., was incorporated into carnation and snapdragon soils at the rate of two inches of the chaff to six inches of bench soil with no harmful effects to the plants. Also, it appeared to be quite suitable for use in potting soils and as a filler and conditioner in fertilizer mixtures.

According to the analyses of the Fertilizer Control Laboratory of the Experiment Station, one ton of coffee chaff has a trade valuation in terms of plant food of approximately \$10 to \$11.

**Packet Seed Studies.** (Clark L. Thayer.) For a sixth season the Department of Floriculture has cooperated with the Seed Laboratory in a test to determine the quality of flower seeds sold in retail seed stores, chain stores, schools, and other retail outlets. The seeds were tested for germination and performance under field conditions.

The test included 218 lots, representing 50 genera, packeted by 32 concerns, and obtained from 80 retail outlets. Records on germination showed 124 lots, good; 55 lots, fair; 31 lots, poor; 8 lots, none. Records on performance showed 165 lots, satisfactory; 12 lots, fair; 41 lots, not satisfactory. Detailed results are reported in Control Series Bulletin 111.

**Floriculture Soil Testing Service.** (Harold E. White, Waltham.) The following tabulation shows the number of soils tested in 1941:

Roses.....	132
Carnations.....	508
Chrysanthemums.....	157
Gardenias.....	74
Snapdragons.....	106
Sweet peas.....	32
Miscellaneous.....	573
<hr/>	
Total.....	1582

## DEPARTMENT OF HOME ECONOMICS NUTRITION

Helen S. Mitchell in Charge

**Vitamin Requirements of Older People.** (H. S. Mitchell and A. W. Wertz.) Very little is known concerning vitamin requirements with advancing age. The favorable reports of the clinical application of vitamins, particularly thiamin, in geriatrics raise the question as to why such deficiencies exist. This study was undertaken with the hope of arriving at a better understanding of vitamin metabolism in older people. The project is partially sponsored by Standard Brands Incorporated.

Work now in progress concerns the correlation between cardiac changes, blood hemoglobin, red cell count, differential red cell count, and thiamin excreted in the urine, with the intake of pure thiamin versus the entire vitamin B complex. If possible the bisulfite-binding substances in the urine and pyruvic acid in the blood will be determined also.

**Thiamin and Pyrimidine Studies on Older Subjects.** (A. W. Wertz and H. S. Mitchell.) (*Proc. Soc. Exp. Biol. and Med.* 48: 259, 1941.) Four men and four women between the ages of 65 and 75 years were used as experimental subjects

in this study. The yeast fermentation method was used to measure the urinary excretions of thiamin and pyrimidine for each individual on graded levels of thiamin intake. There appears to be a sex difference in the excretion of thiamin which is not apparent in the excretion of pyrimidine. The response of people in this age group to increased thiamin intake is similar to that of younger people as far as excretion is concerned. Two out of eight subjects reported no subjective reaction to increased thiamin intake, two noted definite improvement in chronic constipation, four felt less fatigued or "peppier," two enjoyed improved appetites, and one noted an increased thirst.

**Cause and Control of Nutritional Cataract.** (H. S. Mitchell, G. M. Cook, and A. W. Wertz.) The experimental production of cataract in rats by feeding rations containing galactose has become a means of studying the effect of various dietary factors upon the lens. Since it has been well established by earlier work in this laboratory that a deficiency of protein aggravates cataract development and that a liberal supply delays it, the question naturally arose as to what factor in protein is responsible for the protective action. Anti-cataractogenic action of certain nitrogenous factors is being studied.

1. *The Influence of Certain Diamino and Dicarboxylic Amino Acids upon the Cataractogenic Action of Galactose.* (H. S. Mitchell and G. M. Cook.) Following the lead suggested by work reviewed in the 1940 Annual Report, certain individual amino acids are being investigated. It was reported that the enzymic hydrolysate of deaminized casein was somewhat more protective than the deaminized casein from which it was prepared. Of the fractions, the diamino-dicarboxylic acid fraction of the enzymic hydrolysate afforded as much protection as the whole hydrolysate, while the monoamino and proline and peptide fractions showed no protection. Since glutamic acid, histidine, arginine, and lysine are present in the protein hydrolysate fraction found to be most protective, these amino acids have been incorporated in a low-protein galactose ration in order to study any protective action. One of these amino acids has indicated slight protection. It and related compounds are being studied further.

2. *Time Factors in the Development of Galactose Cataract.* (G. M. Cook and H. S. Mitchell.) It has been observed in this and other laboratories that young rats are more susceptible to galactose injury than older rats. An experiment designed to investigate the question of this age factor is in progress. Rats from the same litter are started on experimental rations at fortnightly intervals. The one started later required a longer time for lenticular injuries to become evident. The complete data are not yet available.

The injury due to galactose seems to persist in rats after they have been transferred to rations containing none of this sugar. The blood sugar returns to normal within a few hours after the ration change is made. The apparent lag in the galactose injury must be due to slow diffusion from eye fluids. The extent of this lag is being investigated by discontinuing the galactose ration at four-day intervals in a series of rats from the same litter.

**The Nutritive Value of the Iron of Cocoa and Iron-Fortified Cocoa Mixtures.** (F. Kinder and H. S. Mitchell, with the cooperation of W. S. Mueller of Dairy Industry.) Inasmuch as iron is precipitated in the presence of tannic acid and from 2 to 15 percent of tannic acid is present in commercial cocoa, there arises the question of the availability of the iron in cocoa and foods associated with it. The current use of chocolate milk and chocolate-flavored foods makes the problem one of practical interest.

The nutritive value of the iron of cocoa and iron-fortified cocoa was determined by biological procedure. The iron of cocoa was not so well utilized (approx-

imately two thirds as much hemoglobin regenerated) as an equivalent amount of ferric chloride. The addition of pure tannic acid did not decrease the utilization of iron added to a milk ration. Iron added to cocoa was completely available, indicating that the factor which limited the nutritive value of the iron of cocoa had no influence on added iron. Both cocoa and tannic acid retarded the growth of rats, but the effect of the tannic acid was less severe than that of the cocoa.

It may be concluded from this study on rats that cocoa may be fortified successfully with iron. However, the indiscriminate use of chocolate or cocoa milks is not recommended because of the yet unexplained effect of cocoa on growth and intestinal function.

**Effect of Adding Cocoa to Cow's Milk on Utilization of Calcium and Phosphorus.** (M. R. Cooney, with the cooperation of W. S. Mueller of Dairy Industry.) Interference with the solubility of calcium and phosphorus is a matter of concern when cocoa is added to milk, since cocoa contains oxalic acid, which if present in large enough amounts may prevent the absorption of calcium by the formation of insoluble calcium oxalate.

Accepted standard biologic and chemical procedures are being used to determine whether or not the utilization of calcium and phosphorus is impaired by the addition of cocoa to milk. Results are not yet available.

**The Influence of College Life on the Physical Status and Food Habits of Massachusetts State College Women Students.** (M. S. Gutowska and E. B. Ellms, Department of Student Health.) In order to determine the physical and nutritional status of the women students, a study is being conducted of the basal metabolic rate, the creatine output, and the urine and blood picture of the freshman women students. A general medical examination is the starting point of this study. The dietary habits of the girls as well as their daily intake of calories and protein are recorded through individual computation. Sixty cases have been investigated thus far.

These determinations provide material for an evaluation of the physical status of the women students, and it is planned to continue them for the next three college years.

## DEPARTMENT OF HORTICULTURAL MANUFACTURES

### C. R. Fellers in Charge

**Cranberry Research.** (C. R. Fellers and A. S. Levine.) About 25 percent of the cranberry crop is now used for canned or other manufactured products. Cranberry juice and cranberry sauce were shown to be definitely bacteriostatic for many bacteria of the food-poisoning group. There were also indications that these foods had a marked cleansing action in the mouth.

Cranberries contain small amounts of riboflavin, pantothenic acid, and thiamin not previously reported.

In sauce manufacture, the extraction of the berries with water at 185°-195° F. for 20-25 minutes resulted in increased yields of sauce over the usual short-time extraction at the boiling point. The pectin is conserved and a sauce of improved quality results.

A new concentrated sirup was prepared by first cold-pressing the juice, treating with Pectinol to revive pectin, filtering, and concentrating in vacuum. This sirup serves as a beverage base or as a pharmaceutical vehicle.

**Apple Products Including Apple Juice.** (W. B. Esselen, Jr., A. S. Levine, C. R. Fellers, C. C. Strachan.) In view of the increasing interest in bottled and canned



apple juice, further studies have been made on this product. All of the commonly used methods of clarification were compared in order to determine which would give the best-flavored juice. Flash pasteurizing the apple juice at 185° to 190° F. followed by flash cooling with subsequent filtering, using 2½ pounds filter-aid per 100 gallons juice, was definitely superior to the gelatin-tannin and pectinase enzyme methods. The bentonite method was preferable to the latter two methods but inferior to the first-described method from the standpoint of optimum flavor quality.

Flash pasteurization at 175° to 180° F. and filling hot into the containers, followed by sealing and rapid cooling is recommended.

In Massachusetts the McIntosh is the most important commercial apple crop. Unfortunately the juice of the McIntosh has a rather insipid flavor and must be blended with other varieties to make a palatable apple juice. Tests were made to determine the maximum amount of McIntosh juice that could be blended with Baldwin or Delicious juice to yield a satisfactory commercial product. It was found that blends containing up to 60 percent of McIntosh juice yielded a pleasing product. In such blends it is not recommended that over 25 percent Delicious apples be used owing to their strong aromatic flavor.

Apple juice, fresh or canned, contains little vitamin C regardless of the vitamin content of the apple. Fresh apple juice actually destroyed added vitamin C. However, after inactivation of the oxidizing enzymes by heat treatment, the ascorbic acid remained biologically active in the canned or bottled juice. Ascorbic acid is present in apple juice only in the reversibly oxidized form. It is entirely feasible to fortify processed apple juice with crystalline ascorbic acid at the rate of 20 mgm. or more per 100 ml. of juice. The crystals are first dissolved in the deaerated juice which is then flash-pasteurized and canned or bottled without delay. The containers are preferably sealed under vacuum or by displacement with an inert gas such as nitrogen. Juice fortified by this method retains about 90 percent of the added vitamin C after 3 months.

**Fruit Jellies and Jams.** (A. S. Levine, S. G. Davis, and C. R. Fellers.) The beach plum (*Prunus maritima*) has been used locally for jelly making. Representative samples of the fruits from Cape Cod were collected and some were frozen. Studies are in progress on improved methods of utilizing this fruit in jellies and other products, as well as on composition and nutritive value. Beach plums do not make firm jellies without the addition of pectin, but the added pectin seems to injure the flavor. On the other hand, beach plums make excellent jam without the use of added pectin. The aroma and pleasing astringency are superior to those found in the jelly. It would appear, therefore, that more attention should be centered on the jam and less on the jelly.

The Japanese quince, *Chaenomeles japonica*, a well-known ornamental shrub, produces a considerable quantity of fruits of very pleasing aromatic odor. Attempts were made to utilize these fruits in jelly manufacture. The malic acid content is 5 percent and while considerable pectin is present, the pure jelly lacks character and is excessively acid. Unfortunately, the perfume-like aroma of the fresh fruit is lost in the jelly and in the heat-extracted juice.

**Vitamin C Content of Catsup.** (W. B. Esselen, Jr., and H. Fran.) A survey has been made to determine the vitamin C content of tomato catsup. Samples for analysis were obtained from the local markets and through the courtesy of several catsup packers. The vitamin C content of nine different brands of catsup varied from 0.05 to 0.12 mgm. per gram or from 28.3 to 68.0 I. U. per ounce. This variation in the vitamin C content of catsup is probably due to its air content, possible copper contamination from equipment, storage temperature, and length of time in storage.



**Change in Oxidation-Reduction Potential in Packaged Fruit Juice.** (W. B. Esselen, Jr.) A preliminary study has been made on changes in oxidation-reduction potential in canned and bottled fruit juice. In glass-packed orange juice, there was no correlation between the oxidation-reduction potential and flavor changes which took place immediately after packing. The oxidation-reduction potential of apple juice was much lower in plain tin cans than in enamel-lined cans or bottles. Any beneficial effect that the low oxidation-reduction potential of the apple juice in plain tin cans might have in preventing deleterious oxidative changes was offset by an undesirable metallic flavor of the juice.

**Glass Container Research.** (C. R. Fellers, W. B. Esselen, Jr., W. H. Fitzpatrick, E. L. Moore and J. J. Powers.) Because of the scarcity of tin plate, there has been a marked renewal of interest in glass containers for food packing. Extensive studies have been made on the problems of packing fruits and fruit juices in glass packages. Earlier work on the efficacy of ascorbic acids in preventing discoloration of glass-packed fruits has been confirmed. The use of 1 or 2 one-grain tablets of d-isoascorbic acid or d-glucoascorbic acid in pint or quart jars of canned fruit or vegetables effectively prevented discoloration and off-flavor due to oxidation.

After sealing, commercially packed foods in glass containers lose but little vitamin A and C (*Food Research* 6: 135-141, 1941). Further studies have shown that the total decrease in ascorbic acid is approximately proportional to the enclosed oxygen. Thus, among the important factors influencing ascorbic acid retention are: (1) volume of headspace, (2) degree of vacuum, (3) amount of dissolved and tissue oxygen. Similarly, these same factors may also affect color, flavor, and other characteristics. Modern commercial packaging methods seek to eliminate oxygen from canned foods. This study shows the effect of varying oxygen content on ascorbic acid retention. In fruits and vegetables with high ascorbic acid content (citrus fruits, strawberries, broccoli, etc.), only a small percentage of the ascorbic acid is lost in canning. However, in those initially low in ascorbic acid (pears, peaches, apple juice, plums, carrots, beets, etc.), a substantial percentage, or all, of the ascorbic acid may be lost through reaction with oxygen. Color and flavor of the latter fruits are also adversely affected. High storage temperatures and exposure to light accelerate the ascorbic acid-oxygen reaction in glass-packed foods, but the final total loss of ascorbic acid is unaffected by these factors.

The No. 10 size (105-ounce) glass jar was used experimentally for frozen-packs of strawberries, raspberries, and peaches, packed with and without vacuumization. Results show that vacuum sealing is generally preferable and that this large glass package is very satisfactory for frozen fruits. As in the case of canned fruits, the use of ascorbic acid in small amounts resulted in decreased surface discoloration due to oxidative changes.

**Marine Products Research.** (C. R. Fellers and J. Lubitz.) Cooperative with Poultry Department. New England poultrymen are constantly searching for new low-cost feeds. Recent developments in canning Atlantic coast crabs have made available considerable quantities of crab meal. This product contains about 34 percent protein, 40 percent ash (mainly calcium), and 2-4 percent fat. The riboflavin content is 3-4 gammas per gram. Pantothenic acid, thiamin, and vitamin K are also present. The meal is an especially good source of calcium, magnesium, iodine, manganese, iron, and copper.

In feeding experiments with rats 85 percent of the nitrogen was available, the balance being present largely as unavailable chitin. Upon hydrolysis chitin yields glucosamine, which proved to be entirely unavailable to rats and chicks

as a source of nitrogen. The biological value of crab protein was approximately the same as that of good grade fish meal. Pigmentation in chicks was slightly increased by feeding crab meal as compared with fish meal. In the New England Conference Chick Starter ration the replacement of fish meal by crab meal on either an equal-weight or equal-protein basis gave results highly complimentary to crab meal. Crab meal sells at considerably lower prices than fish meal; it would seem to be a very satisfactory ingredient of poultry rations.

**Dextrose Investigations.** (C. R. Fellers, A. S. Levine, and L. Tarkow.) Studies have been concluded on the relative bacteriostatic and mycostatic properties of sucrose, dextrose, and mixtures of the two sugars. Dextrose kills and prevents the growth of bacteria, yeasts, and molds at lower concentrations than does sucrose. That is, dextrose sirups (above 30 per cent) are far less liable to ferment or mold than similar sucrose sirups. The use of dextrose in canned foods, in carbonated beverages, and in soda-fountain crushed fruits and sirups is rapidly increasing. The smaller molecule and the greater osmotic pressure exerted by dextrose in solution are believed to contribute to the greater preserving value of this sugar.

**Red Squill Research.** (A. S. Levine, C. R. Fellers, and J. Lubitz.) Improved methods for rat extermination are now more important than ever before in reducing the nation's loss by waste.

Red squill was found to be harmless for chickens and rabbits. Guinea pigs are more susceptible than rats to red squill poison. Some popular flavors have been found to be of little value as rat lures. Among these are meat, cheese, anise, caraway, cinnamon, and peppermint flavors. The composition of common baits used as carriers for the squill had little effect on the toxicity of the poison to albino rats.

On account of the war there is now no importation of red squill, and most stocks of red squill still in this country are of low toxicity to rats. Through concentration and subsequent bioassay studies an attempt is being made to increase the toxicity of the present supply.

Three papers have been published on red squill research.

**Preservative Values of Organic Acids.** (A. S. Levine, R. E. Morse, and M. G. O'Connor.) The addition of small amounts of acetic acid (vinegar) does much to improve the keeping qualities of soda fountain sirups and fruit juices with no impairment of flavors. The addition of only 0.3 percent acetic acid inhibited both yeast and mold growth in strawberry and raspberry sirups. This is especially favorable when compared with the high amounts of citric and lactic acids required for complete inhibition. More than 6 percent citric acid or 5 percent lactic acid was necessary to inhibit yeast growth in these sirups. Four percent lactic acid prevented mold growth but the mold, *Aspergillus niger*, grew in sirups containing over 7 percent citric acid.

Benzoic acid and especially sodium benzoate are still used extensively for the suppression of yeasts in the preservation of fruit juices and sirups. A study is now in progress to determine the effect upon yeasts when definite concentrations of sucrose, dextrose, alcohol, and sodium chloride are used in conjunction with the benzoates. In the preservation of apple juice as much benzoate was required to preserve the clarified as was needed for the unclarified or cloudy juice.

## DEPARTMENT OF HORTICULTURE

R. A. Van Meter in Charge

## Propagation of Hemlock. (Harold S. Tiffany, Waltham.)

*Canadian Hemlock, Tsuga canadensis.* Cuttings of one-year wood were taken from hedge trees approximately fifteen years old, in three series at five-week intervals: December 9-14, 1940; January 13-18, and February 17-21, 1941. The rooting medium was one-third peat and two-thirds sand, in open benches under cheesecloth tents and whitewashed glass. Cuttings were kept fairly moist. All treatments were run at constant temperatures of 65°, 70°, and 75° F. (maintained by electric cable), as well as in an unheated bench where the temperature averaged about 60°. Each lot consisted of six cuttings.

Immersion treatments consisted of honey, 25 and 50 percent solutions for 24 hours; indolebutyric acid in the form of Hormodin A, at concentrations of 30, 45, 60, 75, 90 BTI units for 24 hours (with additional treatments at certain temperatures); indolebutyric, indoleacetic, and naphthaleneacetic acids, each at concentrations of 7½, 10, 12½, 15, 20, 30, 40, and 50 mg./100 c. c. water for 24 hours (with additional tests for 16 and 40 hours); Roche 202, at 50, 100, 200 unit solutions for 24 hours. Powder treatments consisted of Formula No. 66 and Hormodin Powders Nos. 2 and 3. An untreated or check lot was included.

Untreated lots rooted little or not at all: at 60° F., 16 percent; at 65°, 33 percent; at 70°, 16 percent; and at 75°, none. Rooted cuttings of successful lots could have been potted at ten to twelve weeks.

Outstandingly rapid rooting, as compared with other treatments, was shown by Hormodin A, 30 BTI units for 24 hours at 75° F. This reaction checked similar findings of the previous season (Hormodin A, 45 BTI units for 24 hours). See photograph page 56.

Cuttings from Series I, taken in early December, gave much higher percentages of rooting than those of Series II or III. In the previous year mid-December cuttings did not root as successfully as those taken in mid-January. This variability can be at least partially explained by the early low temperature and snow fall of November 1940 which brought the cuttings to a condition for satisfactory rooting much earlier than was the case in the preceding year when such conditions did not materialize until January.

Of the thirty-one treatments which gave 100 percent rooting, the most consistently successful was indolebutyric acid 7½ mg./100 c. c. for 24 hours. The finest normal root systems were developed with this treatment at 65° F. (see photograph, page 56), with good rooting at 70° and 60°. Of economic significance is the fact that this treatment gave 83 percent good rooting in the unheated bench at an average temperature of 60° (widest fluctuations in the bench temperature were 57° and 63°). Consistency of the treatment at 65° is further shown by 100 percent rooting from 7½ mg. upward through 40 mg., although as the concentration increased the roots were shorter and some injury was apparent.

Hormodin A trials were consistently good with percentages of 100 on half the lots. Best-developed root systems were from 90 BTI units, 24 hours at 65° F. As would be expected, lower concentrations did best at higher temperatures and vice versa. This was shown particularly well by the best 100 percent rootings in the Hormodin A, 24-hour trials: 30 BTI at 75°, 60 BTI at 70°, 90 BTI at 65° and 60° F.

Cuttings treated with indoleacetic acid gave 100 percent rooting at 60° and 65° F. with concentrations up to 10 mg./100 c. c. In no instance did the condition of the roots excel or equal the condition of those treated with indolebutyric acid.

All naphthaleneacetic acid treatments gave indication of injury by basal burn



and proliferation of roots. Roche 202 treatments gave variable results—from 0 to 100 percent rooting. As in the case of most treatments, best rooting was at 65° F.

Hormodin Powder No. 2 brought 83 percent rooting at 70° F., but fell to 66 percent at 65°. Hormodin Powder No. 3 gave best rooting at 65°—100 percent. Root development with powder treatments was much inferior to that produced by immersion treatments of indolebutyric acid. The results with Hormodin Powder No. 3 were generally paralleled by Formula No. 66.

*Tsuga canadensis* vars. *pendula* and *minima*. Results of treatments suggest these varieties propagate readily. The records approximately parallel those for *T. canadensis*.

*Tsuga canadensis* var. *Beaujean*. Preliminary tests of twelve lots suggest that this variety does not propagate so readily as those mentioned above.

Generally, indolebutyric acid has shown definitely superior results to other treatments in these trials and at low concentrations. A constant temperature of 65° F. appears optimum throughout the trials, with the exception of Hormodin A at 30 BTI at 75°. Cuttings rooted best when taken soon after the first protracted cold weather of the season.

Tests will be continued in 1941-42 with indolebutyric acid in various forms at minimum concentrations and optimum temperatures.

**Propagation of Mountain Laurel.** (Harold S. Tiffany, Waltham.) Preliminary trials in 1940 gave indication of a low percentage of rooting from hardwood cuttings of mountain laurel, *Kalmia latifolia*, taken in mid-January. Treatment with indolebutyric acid in the form of Hormodin A at 60 BTI units for 16 hours gave 20 percent rooting, while fairly high concentration of the salts gave only 10 percent. These roots developed in a sand medium; no roots developed in a medium half sand and half peat, or in peat alone.

Since successful propagation of the best white and deepest pink variations of mountain laurel would be of decided value, a program of winter propagation trials was carried out during 1940-41. Three series of cuttings were taken: December 19-26, 1940; January 30-February 6 and March 13-20, 1941. Thirty-eight treatments (plus other varied trials) in lots of six cuttings each for each series were duplicated at constant temperatures of 65°, 70°, and 75° F., and in an unheated bed averaging 60°. These were as follows: honey, 25 and 50 percent solutions; Formula No. 66 and Hormodin No. 3; Hormodin A at 45, 60, 75, 90, 120, 150 BTI solutions; indolebutyric, indoleacetic, naphthaleneacetic acid salt solutions at concentrations of 10 mg./100 c. c. through 80 mg./100 c. c. (10 unit progression); Roche 202 at unit strengths of 50, 100, 200, 300; and an untreated lot.

While rooting percentages of the previous season's tests were perhaps slightly bettered (33 percent), it appears from these results that the propagation of mountain laurel from hardwood cuttings may not be feasible.

The twenty-eight plants rooted did not continue root development after transfer to pots, seeming to hold only growth that had been made in the rooting medium. The cuttings rooted in 1940 also exhibit an equal lack of normal vitality.

**Propagation of Lilac.** (Harold S. Tiffany, Waltham.) The time of taking cuttings of the common lilac, *Syringa vulgaris* var. *Andenken an Ludwig Spaeth*, has been varied from May 28 to July 1. In no instance have rooting percentages been as high as for those taken in late May at the time the flowers are about half way into bloom. At this time the new growth is about 6 to 8 inches long, making for good-sized plants when rooted. Rooting percentages of the 1200 cuttings taken for test June 10, 1941, about two weeks after the optimum time, fell off



from 30 to 40 percent. Optimum temperature of the medium, one-third peat and two-thirds sand, was found to be about 70° F. Hormodin A, 40 BTI units for 24 hours, and Formula No. 66 each gave 95 percent good normal rooting.

**Propagation of *Juniperus virginiana* var. *glauca*.** (Harold S. Tiffany, Waltham.) Several varietal forms of *Juniperus virginiana* are propagated commercially by grafting to understocks of this species, since no satisfactory percentage of rooting has been obtained from cuttings. The variety *glauca* is one of these.

Preliminary trials in 1940 of wood of the current season and of two-year wood gave high rooting percentages on the one-year wood and very low percentages of rooting on the two-year wood. Both sand and half sand, half peat appeared satisfactory media, although cuttings in the sand-peat rooted satisfactorily in 11 weeks, while those in the sand consistently required 14 weeks.

A series of cuttings, twenty to each treatment, taken in late January 1941, were put in sand-peat in open unheated benches at a temperature averaging 62°. Thirty-four treatments with root-inducing substances were made for 16, 24, and 40 hour immersions.

Indications show successful rooting confined to indolebutyric acid treatments with a range of rooting percentages up to 100. Untreated cuttings gave no indication of rooting. A higher temperature of the rooting medium appears to be necessary for best results.

**Factors Increasing the Rapidity of Growth of Nursery Stock.** (Harold S. Tiffany, Waltham.) To determine best cultural practices for rapid quality growth of lining out stock, plots of various plant materials have been laid out from 1939 through 1941. These include plantings of *Tsuga caroliniana* and *canadensis*, *Thuja occidentalis* var. *globosa*, and *Syringa vulgaris* var. *Souvenir de Ludwig Spaeth*.

A series of fertilizer treatments was applied in duplicate, in 1940 and 1941, to fourteen plots of *Tsuga caroliniana*. Treatments were based on 5-8-7 (one third ton per acre) as a balanced fertilizer adequate in amount for the needs of young evergreen trees. One-half the nitrogen was supplied by nitrate of soda and one-half by sulfate of ammonia. Phosphorus was supplied by superphosphate, and potash by muriate of potash. Manure and peat moss represent two other treatments.

Growth measurements in inches for each of the years 1940 and 1941 were secured from plots treated with manure (15 cords per acre) and peat moss (annual application of 2 inches hoed into the soil).

While other treatments also show measurements exceeding those of the untreated plots, further results are needed before conclusions can be drawn.

**Study of Herbaceous Perennial Material.** (Harold S. Tiffany, Waltham.) Records of the 1941 season have been included with material previously obtained, giving the average time and duration of bloom, height, and color of the better and enduring garden perennials. Averages for a period of five years are now available for most of the plants.

Additions to the peony collection, chosen as representative of the best of their types from a study made by the University of Illinois and the American Peony Society, are as follows: Single—Catherine Parry, Departing Sun, Harriet Olney, Le Jour, Marguerite Dessert, Mellin Knight, Mischief, Shirley Walker; Japanese—Antwerpen, Cathedral, Fuyajo, Hakodate, Kukenu-Jishi, Margaret Atwood, Mikado, Some-ganoko, Surugu.

**Hardiness Trials of Clematis Varieties.** (Harold S. Tiffany, Waltham.) A limited number of three-year plants was set in the nursery, from pots, in the

spring of 1940 and given a severe test the following winter without the benefit of winter protection.

The only 100 percent survivors after a winter during which a lasting blanket of snow offered good protection, were the varieties Mme. Edouard Andre, Elsa Spath, and Duchess of Edinburgh. Over 75 percent of *Comtesse de Bouchaud* lived; 66 percent of *Henryi*; and 50 percent of *Romona* and *montana* var. *rubens*. The species *ascotiensis*, *crispa*, *langutica* var. *obtusiuscula*, and the varieties Belle of Woking, Gipsy Queen, Mrs. Cholmondeley, Nelly Moser, Ville de Lyon, and Ville de Paris were entirely winterkilled.

While the number of plants was insufficient for a thorough test, and although the test represents but a single winter, the hardiness of the plants of Mme. Edouard Andre, Elsa Spath, and Duchess of Edinburgh is promising.

**Powdery Mildew on Garden Phlox.** (Harold S. Tiffany, Waltham.) A spray control program of Bordeaux mixture 1-1-50, Hammond's Copper Solution 1-150, Basi-Cop 1-50, and Wettable Sulfur 2½-50 was applied to plantings of *Phlox paniculata* from May to the time of flowering. Applications were made at intervals of 7 to 10 days.

Hammond's Copper Solution, with no residue, was again superior in both control and appearance to Bordeaux Mixture, which left some residue on the plants. Wettable sulfur gave better results than did Basi-Cop.

**Factors Influencing the Hardiness of Evergreens.** (Harold S. Tiffany, Waltham.) Records of terminal growth averages on *Taxus baccata repandens* after the first season of cultural treatments showed a definite correlation of growth with treatment. Sod with no cultivation afforded fairly normal growth, yet the plants lost much of this growth by the next spring. Cultivation with no fertilizer gave a normal amount of growth, and these plants suffered least from winter injury. The spring application of nitrate of soda at the rate of 300 pounds per acre gave the most growth, yet the plants were not injured comparably. As expected, greatest winter injury came from manure, 15 tons per acre applied in May and in August.

Winter injury is calculated by (a) the number of terminals entirely winterkilled, (b) terminals killed approximately two inches from tip down, (c) tip injury to the bud with approximately ten needles killed, and (d) number of retarded terminals after growth has started. After trying several methods of measuring winter injury, this means appears to hold fairly constant.

In 1941 additional fertilizer was given with the late August application of manure for still further contrasts. A cover crop of annual rye grass was planted in August on the nitrate of soda plot to check growth early and encourage hardening after a rapid early growth.

The dry 1941 season consistently lessened growth averages by approximately 25 percent. An exception to this was plants of *Taxus canadensis stricta*, which showed more average growth than in the previous season in all plots. Explanation may be that the plants had not become fully established at the end of the first season of treatments, or that they withstand drought better than either *Taxus baccata repandens* or *Taxus cuspidata*.

**Propagation of Mugho Pine.** (Harold S. Tiffany, Waltham.) A series of cuttings of Mugho pine, *Pinus mugo* var. *Mughus*, was given preliminary tests in 1939-40, and the work for 1941 was based on the results of these tests.

Lots of five cuttings each of one-year wood taken in January were placed in open benches, in a rooting medium of one-third peat and two-thirds sand, with temperatures averaging 65° and 62° F. Dip treatments consisted of Formula No. 66 and Hormodin No. 3; immersion treatments, of honey 25 and 50 percent

solutions, Hormodin A at 30, 45, 60, 75 BTI units, indolebutyric, indoleacetic, and naphthaleneacetic acids at concentrations of 10, 15, 20, 25, 30, 35, 40, 45, 50, and 60 mg./100 c. c., Roche No. 202 at unit concentrations of 25, 50, 75, 100, 125, 150, 175, 200; and an untreated lot. Each immersion treatment was continued for 16, 24, and 40 hours.

A series of fifteen cuttings to the lot was taken in February and run in sand and sand-peat at a constant temperature of 65° F. Treatments were Hormodin A at 90, 105, and 120 BTI units, with additional test treatments of indolebutyric acid. Results were slightly better from the sand-peat medium than from the sand, and from a higher temperature of the rooting medium. Highest rooting percentage was 80 with indolebutyric acid at 40 mg./100 c. c. for 24 hours at 65° F. in sand-peat. Immersion treatments for 24 hours with Hormodin A at 90 BTI units (in sand) and at 120 BTI units (in sand-peat) gave 66 percent rooting; and at 90 BTI units (in sand-peat) 65 percent rooting at 60° F. In the untreated lots a single 13 percent rooting occurred at 65° F. in the sand-peat medium. Rooting from other lots was negligible.

## DEPARTMENT OF OLERICULTURE

### Grant B. Snyder in Charge

**Variety Studies.** (W. H. Lachman and G. B. Snyder.) These studies are conducted each year to ascertain the adaptability and general usefulness of the newer introductions in comparison with the standard vegetable varieties. The weather conditions at Amherst during the summer of 1941 were very near to the average for the last 50 years and were ideal for proper growth and development.

Especially noteworthy was the new "Summer Pascal" celery which produced a medium large plant weighing a little over two pounds and measuring about 20 inches in height. This variety produced a crisp, succulent stalk with an excellent nutlike flavor.

There were 62 strains and varieties of tomatoes included in the trials. Particularly outstanding were "Stokesdale," an early mid-season variety which yielded well and had good shape and size, and "Rutgers," a late, high-yielding, very attractive tomato which is especially valuable for canning. The varieties "Victor" and "Bounty" which are early varieties proved a little disappointing because of poor fruit color and sparseness of foliage. "Pan American," a new introduction of the U. S. D. A., is reported to be highly resistant to fusarium wilt. This variety has excellent foliage, but from the experience gained by limited trial, large plantings are not suggested because of only a moderate yield and variable fruit shape and size when grown either pruned and trained or unpruned and untrained.

During the summer, eight varieties of tomatoes were tested for vitamin C, with the following results:

Variety and Source	Ascorbic Acid (mg. per gram of tomato)
Bounty—N. D. Agr. Expt. Sta.....	.15
Early Rutgers—N. J. Agr. Expt. Sta.....	.20
Gradwell—Scott.....	.21
Marglobe—Landreth.....	.17
Ohio Red—Ohio Agr. Expt. Sta.....	.16
Pan American—U. S. Dept. Agr.....	.21
Victor—Harris.....	.17
Waltham Forcing—Waltham Field Station.....	.23



Also important among the newer vegetables was the "Yankee Hybrid" summer squash. This variety is from three to seven days earlier than standard varieties. It has a straight neck, good quality, uniformity, and gives an exceptionally high yield over a long season. The "Delicious" and "Golden Delicious" varieties of winter squash were outstanding in quality and store moderately well.

**Shape Index Studies of Tomatoes.** (W. H. Lachman.) Five years ago a quantity of seed was obtained of eight varieties of tomatoes that displayed major differences in the shape of their fruits. Each year small plantings have been made from the original stocks of seed to determine the effect of the various weather conditions in modifying the shape of tomato fruits. While considerable data have been collected, it is felt that more information is necessary before the results are summarized.

**Tomato Breeding.** (W. H. Lachman and G. B. Snyder.) The tomato breeding project has been confined to the problem of incorporating the uniform ripening gene into otherwise desirable tomato varieties. The uniform ripening character is inherited in a simple manner and is dependent upon one pair of genes for its expression. During the past season an  $F_2$  population of 293 individuals was grown and the ratio was 3.37 normal green-shouldered individuals to one of the uniform ripening. The uniform character appears to be a recessive, and these results agree with the work of other investigators.

Many single plant lines have been established, some of which are in the  $F_6$  generation. The main difficulty has been to obtain lines which have sufficient foliage to provide an ample coverage for the fruits and thus prevent sunburning. Many of the original lines were determinate in habit of growth; that is, the main stem grew for a short distance and then was terminated by a blossom cluster. Any subsequent growth was made by lateral branches.

Most of the more recent selections made have been indeterminate in habit and thus the coverage of foliage is much better. Also, this type of plant can be pruned and trained to a much greater degree of satisfaction. It is planned to multiply the seed of the three best lines so that they can be sent out for trial among a number of vegetable growers.

**Sweet Corn Breeding.** (W. H. Lachman.) The object of the corn breeding program has been to develop a hybrid which would provide earliness, productivity, disease resistance, and quality. During the past five years a system of inbreeding has been practiced in an effort to obtain superior inbred lines with characteristics which are sought in the hybrid. Approximately 100 such inbred lines have been obtained and the work now consists of testing the inbreds in various combinations of crosses to ascertain which of the combinations are most desirable.

During the past summer 40 such combinations were planted and carefully studied during the growing period. Five of these performed especially well and have been recommended for further trial. If they grow and produce as well in another season, the seed stock will be multiplied and sent out for trial among a number of vegetable growers. More combinations of the inbreds have been made and will be tested further.

**Hybrid Sweet Corn Trials.** (W. H. Lachman.) Hybrid corn has taken the country by storm. Many varieties have been introduced lately and the list grows longer each year. It has been recognized, however, that each hybrid has a narrow range of adaptability because they are susceptible to very small changes in environment. Hence, regional tests must be made before any hybrid can be recommended for production within very narrow limits or localities.



Therefore, tests are conducted each year, particularly of the yellow varieties, to observe earliness, yield, quality, disease resistance, and general adaptability for this locality. Of the hybrids that have been tested for the past three years four are especially noteworthy.

Spancross (C4×C13) is an extra early, very productive hybrid, and matures in about 70 days. It has good quality, is very uniform and has a medium-sized ear measuring about  $6\frac{1}{4}$  inches in length. This variety is two or three days earlier than Golden Early Market.

Marcross (C6×C13) has a large ear, about eight inches long and is an early-maturing variety. It is only four or five days later than Spancross but not quite so good in quality.

Marcross (P39×C13) also known as Carmelcross is a mid-season variety which matures in 80 to 82 days. This variety produces a large ear and has excellent quality and appearance.

Golden Cross Bantam is a late market corn which matures in 85 to 89 days. It produces a good crop of cylindrical, well-filled ears that are of exceptionally fine quality. This variety is highly recommended.

**The Effects of Mulching Tomatoes and Peppers.** (W. H. Lachman and G. B. Snyder.) Each season soil moisture becomes one of the most limiting factors in the production of vegetable crop plants. Any treatment or practice which will aid in conserving soil moisture for plant use during critical periods becomes especially significant to the vegetable grower.

Various mulches have been applied to the soil and compared with clean cultivation in the culture of tomatoes and peppers. Straw, banana fibre, and horse manure were the materials used. Based on the results of the tests for two years, it is doubtful whether mulches have a significant influence on yield, cracking, or quality of the fruit.

If mulching was continued for several years it is conceivable that the increase in organic matter might exert a more marked influence on growth and production. The applications of banana fiber changed the soil pH from 5.7 to 7.0, but this change was not reflected in the growth of the plants.

Samples of soil were taken from each of the plots and chemical analyses made by Philip H. Smith of the Control Service. The results show that the various treatments had a rather insignificant influence upon the mineral content of the soil. The soil under the banana fiber mulch is considerably higher in potassium, but other differences are either lacking or not significant.

**Cucumber Seed Treatment.** (O. C. Boyd and W. H. Lachman.) Samples of pickling cucumber seed were obtained and treated to control seed-borne diseases as well as diseases caused by soil-inhabiting organisms. Dusting the seeds with red copper oxide, whether they had been previously soaked in mercuric chloride solution or not, just doubled the stand of seedlings. The principal benefit of this treatment was the prevention of seed decay and pre-emergence damping-off, rather than the prevention of post-emergence damping-off. There was no evidence of injury to germination by any of the treatments.

**Sources of Organic Matter for Greenhouse Tomatoes.** (W. H. Lachman and G. B. Snyder.) The scarcity of animal manures as a soil amendment has led to a search for substitute materials. The main object was to find a cheap material which would provide a good source of organic matter and support the growth of greenhouse tomatoes. Straw and peat moss were the two materials best suited for the problem. Straw has proved to be the better of the two materials and is more economical. Both materials, however, must be supplemented with sufficient commercial fertilizer to compensate for the nutrients supplied in manure.

**Tri-State Cooperative Vegetable Variety Project.** (G. B. Snyder and W. H. Lachman.) This project is conducted in cooperation with the Rhode Island and Connecticut Experiment Stations. The object is to ascertain the influence of the various climatic and edaphic factors upon several strains of beans, sweet corn, peppers, cabbage, celery, tomatoes, and carrots. The data for four years are now being summarized.

**Bean Culture.** (W. H. Lachman and G. B. Snyder.) One of the limiting factors in the culture of lima beans has been the sparse stand of plants obtained because of poor germination. A rather comprehensive test was made of the value of "Sperton," a commercial preparation used as a dust on the seed. The seed treatment increased the germination about 25 percent and the treated plants were more robust and healthy than the untreated lots.

A number of varieties of edible soy beans have been tested for two years. The varieties "Giant Green" and "Willomi" performed especially well and have a very pleasing flavor. One of the reasons why the public has hesitated to accept soy beans as a vegetable is because they are so difficult to shell. It has been found that the beans shell very easily if they are first boiled for about three minutes. The beans can then be cooked and served much the same as lima beans.

**Asparagus Investigations.** (Robert E. Young, Waltham.) The yields of 450 plants in five different lines derived from previous selections were in a somewhat different order from those of last year. The yields did not increase as would be expected for asparagus plants that have been cut only two full cutting seasons. The strain that produced the greatest yield last year was second in 1941.

Although the production of the best strain was about double that of the poorest strain and of plants from commercial seed growing alongside, the results of these individual cutting records show that there is a wide variation in the performance of the plants of even the best strain. That the yield can be doubled in one generation establishes great possibilities in asparagus breeding.

Increasing the yield gave a slight increase in the percentage of extra large stalks, and a slight increase in the average weight. In checking the performance of the 25 highest yielding plants it was found that there was a great variation in the type of spears produced. Some plants produced very few large spears but many small ones, while others giving as much in total yield produced mostly large-sized stalks, although when the strains were taken as a whole this difference did not show to any great extent. In the best strain 24 percent of the plants produced a bunch of asparagus (1.25 pounds), while in the commercial strain only 2.5 percent produced as much.

At the time of the fall stalk count, quite a number of plants had rust in varying degrees of severity, including the commercial line of Mary Washington, supposedly rust resistant. The percentage of rust present in the selected strains in the order of their yield was 14.2, 17.0, 13.0, 5.0, 3.3, compared to 39.7 percent for the commercial strain. This would indicate that progress can be made in obtaining not only better yield but also better resistance to the rust disease.

The various characteristics of yield, size, bud shape, height of branching, spreading of tips, and color are so variable that new selections will be made next year to secure more uniformity.

**Vegetable Breeding for Improvement of Quality.** (Robert E. Young, Waltham.)

**Trellis Tomato.** The program of developing better internal and external fruit quality in our two strains of trellis tomatoes has been continued. For reasons not wholly understood, the yield of the 1941 tomato crop was only about 50 percent of last year's although the plants set and the care given were better. Poor tomato crops were reported all along the eastern seaboard. The dry weather, no doubt,

had its effect, but our plants were irrigated and did not suffer for water. The earliness was not affected but there was a general lack of vigor and insufficient foliage.

A number of hybrids were made in the greenhouse last year in order to introduce certain characters of quality, also to test other varieties as to their value in combining with our strain to produce a satisfactory hybrid. One of the varieties used was Victor, a new determinate type, early, with uniform ripening of the fruit. At that time it was thought that the uniform ripening character was a desirable one for our strains. The hybrids of this cross did not have the usual vigor of the other tomato hybrids. The stems were weak and small. Insufficient replicates were grown to make possible an accurate determination of yield but the yield of early fruit was not so heavy as would be expected. During the season observations were made of the way the fruit of the Victor, and other varieties having uniform ripening character, colored and there is now a question whether this character is desirable in our trellis types. A cross between Trellis No. 22 and a late, vigorous Comet was much later than would be expected. This cross was made to obtain more foliage for a tomato of the No. 22 type.

From the behavior of these and other hybrids, it would seem that our trellis type tomatoes exert very little effect on the hybrids in which they are used.

It has recently been reported that the hybrid vigor of summer squash exhibited in the  $F_1$  generation was carried over into the  $F_2$  population. This  $F_2$  lot of plants, while showing segregation as to size and shape, still had earliness and yield. If this fact should be true for tomatoes, it would be easy to produce the  $F_2$  population from a few hand-pollinated hybrid fruits. To determine whether tomatoes will behave in this way several plots were grown of the parents  $F_1$  and  $F_2$  of Waltham Forcing  $\times$  Early Rutgers. The poor crop made it difficult to evaluate the results but it would seem that the  $F_2$  of this hybrid was about as good in production as the  $F_1$ . Further study will be made of this factor and a rating of the desirability of other varieties as parents in such a program.

During winter meetings with the growers the question has been asked as to the value of using early started tomato plants. Certain growers felt that an older plant will produce earlier. To test this contention seed of the Waltham Forcing tomato was sown on February 15. The plants were carried along slowly and transplanted several times, but at setting time they were really overgrown. They were not potted but dug out of the bed with a ball of soil. These plants had  $\frac{3}{4}$ -inch fruits at setting time. The regular crop was started April 1 and transplanted in a bed in the greenhouse  $2 \times 2$  inches, then to the coldframe  $4 \times 4$  inches. These plants also were set with a ball of soil. It is true that the early started plants had ripe fruits very early, but they were small; during the first three pickings they produced an average of 8.5 fruits that weighed .92 pound per plant, compared to 11.3 fruits weighing 1.6 pound per plant obtained from the regular crop. The total yield from the early started plants was 1.95 pounds compared to 2.69 pounds from the plants started at the regular time, and from these results it would seem that if plants are to be started early they must be grown in pots or baskets. These plants were very slow to start growth after setting.

*Greenhouse Tomatoes.* During the year trials of various hybrid tomatoes have been made to see which will combine with the Waltham Forcing and Bay State to produce a good tomato with hybrid vigor. An  $F_2$  generation of a cross between Waltham Forcing and Michigan State Forcing was also grown, and the results indicate that the  $F_2$  plants are vigorous. The yield was very high although the fruit was not very uniform.

A discovery that may make the production of hybrid seed much easier is that the tall non-productive plants that have frequently been found in the Waltham Forcing strain in the greenhouse are only partially sterile. Pollen from good



plants will cause the sterile plants to set seed. If these plants can be used, there will be no need of emasculating the flower to obtain hybrid seed.

*Summer Pascal Celery.* This year 20 different single-plant selections of Summer Pascal celery were tested to determine whether a longer petioled strain could be obtained; and no irrigation was supplied after the paper for bleaching was applied, in order to determine whether there were differences in the susceptibility to heartburn. Some of the single-plant selections showed almost 100 percent heartburn, while the best had only 25 percent. This severe heartburn provided an opportunity to make selections that did not heartburn for the supply of stock seed.

The results of trials in past years have shown that seed from selected celery plants grown in the fall cannot be raised in time for the next year's crop. Experimental work with light and heat has not hastened the seed stalk development to any extent. A crop of seed was raised outside to provide ample supply of stock seed for our growers. The demand for Summer Pascal celery is greatly increasing.

*Greenhouse Lettuce.* The third generation of a cross between Bel-May and an English variety, Cheshunt Giant, was grown at the Waltham Field Station and in two growers' houses. Selections were made and seed produced of the most promising. The hybrids have darker green color and better overlapping of leaves on the bottom, and are slower bolting to seed. It will require another generation or so to completely remove the off-type plants from the strain.

*Rutabaga or Cape Turnip.* A good crop of turnips was produced on the Field Station grounds. As a result three distinct types have been selected, and sufficient seed will be grown to enable the growers to try them on their own farms. Type No. 1 has white flesh with white or light green shoulder, and the root is almost uniformly colored from top to bottom. Type No. 2 has white flesh with a slight purple shoulder. Type No. 3 has yellow flesh but is otherwise of the same character as Type No. 2. Most yellow-fleshed turnips have a dark purple shoulder.

The type of soil at the Field Station is such that a good turnip crop is not assured each year and if further work is needed it should be done in the turnip sections such as Bristol County.

*Wyman Crosby Beet.* There seems to be a definite correlation between speed of growth and color in beets. The larger roots of the Wyman Crosby strain of beet always seem to be of poor color, while the small roots are usually a dark red color. Twenty-five different selections of single and mass roots were grown and several proved to be very uniform and somewhat of a compromise in that they were of dark color and medium speed of growth. It will require time to build up sufficient seed to try these out on a large scale.

*Greenhouse Cucumbers.* About 30 different strains and varieties were grown for self-pollination in the field. Some of the strains are approaching sufficient uniformity to permit the hybridization program to be undertaken. Some experimental hybrids tried during the year have been outstanding in yield. The past year's crops have shown that there is a large difference in the vigor of the various lots under trial. Only about 40 percent of the self-pollinated blossoms set fruit, and further study will be made of the methods of pollination and also the effect of homozygous conditions of fruit setting.

*Green Sprouting Broccoli.* Both the spring and fall crop have afforded an opportunity to make selections of the crosses made during the winter in the greenhouse. Crosses were made between several quite widely different types. The



F<sub>1</sub> generation has shown that there is a large difference in uniformity between hybrids made between homozygous parents and crosses in which one or both parents were from commercial strains. It will require considerably more testing before the real value of any of the lines can be determined.

*Hutchinson Carrot.* The F<sub>4</sub> generation of a cross of Hutchinson × a Turkish red carrot was grown during the fall. While many of the other vegetable crops this season were poor, the carrot crop was the best in years. The hybrid material was so promising that several lines will be increased for further testing on a larger scale. These new lines have a very uniformly colored root and have a pleasing external color much darker than the Hutchinson.

The stock seed crop of Hutchinson carrot was very small. The plants blossomed profusely but only a small percentage of the flowers set seed. It is probable that the dry weather was not conducive to proper fertilization. To meet the demand for this seed from the seedsmen, a large crop of roots was grown and placed in storage for next year's crop.

*Lettuce, New York Type.* Three crops of lettuce grown during the season have shown that the strain of lettuce which, because of past performance, was thought to be the most satisfactory will not stand during hot weather without bolting to seed. The early crop, in which plants are set, was small but satisfactory. Comparisons were made, and the better selections showed up well. The first crop in which the seed was planted directly in the field, and which matured in early July, indicated that the best selections definitely had resistance to tip burn.

In this planting was some of a newer selection about ready for release by the U. S. Department of Agriculture which showed excellent heading characteristic, but was small and so crisp as to make it questionable whether it would stand handling in the market. The characters this lettuce has will be combined with our bigger strain resistant to tip burn, which should combine all the desirable characters needed to make a good lettuce for Massachusetts. The fall crop of lettuce confirmed the results obtained in the summer crop.

Samples of the best selections now on hand will be given to a few growers for trial next year.

## DEPARTMENT OF POMOLOGY

### R. A. Van Meter in Charge

The past season was in strong contrast to that of 1940 in many respects. It opened early and fruit trees bloomed earlier than in any other of the past twenty years. Rainfall was very deficient in the spring of 1941, normal or above in June and July, and low for the last of the summer. Rainfall was heavy in the spring of 1940 and light in the fall, while fruit bloom was late. The rainfall for the summer of 1941 was less than three fourths of the normal amount in Amherst and still less in some parts of the State. Yet tree growth was good at Amherst and apples grew to normal size. The explanation may be largely in the good rainfall for June and July. Trees came through the spring drouth on reserve water from the winter. Soil water drained away early, admitting air to the soil and favoring early root activity and later leaf development. Summer rainfall was enough to maintain growth. Dry weather in the spring is favorable to fruit trees provided it does not continue too long.

Peach fruit buds survived the winter and a good crop was produced. Raspberry canes winterkilled badly, with a consequent reduction of the crop.

**The Influence of Various Clonal Rootstocks on Apple Varieties.** (J. K. Shaw and L. Southwick.) The new stock bed set last year made a good growth and should yield several thousand rooted layers in 1942. Several new stocks from the United States Department of Agriculture were added. No layers were taken from this bed this year but the old bed yielded a crop of layers that were lined out for budding. Layers from the more vigorous stocks can always be budded the first season but the dwarfing stocks require good growing conditions if they are to be suitable for budding in their first year.

The cooperative clonal stock orchards are as reported last year. Some are doing well and should contribute to our knowledge of the interrelations of these stocks with our American varieties; others are failures. One orchard that did very poorly for the first three years has improved greatly in the last two years. It is on a shallow soil with a high water table in the spring. During the past two years it has been cultivated with a crop of string beans. The reason for marked improvement may be that aeration of the soil has improved conditions for root activity. An additional cooperative orchard of over 1000 trees on these clonal stocks will be planted next spring.

All the trees in our own five-year-old orchard continue to grow about alike. They have been in cultivation and have borne few apples, yet they are now large enough to bear a bushel or more each. The orchard will soon be seeded to grass which should bring the trees into bearing promptly and show whether the trees on the various stocks react differently. Two trees of Red Spy on the very dwarfing Malling IX, one with several apples, broke off, emphasizing the fact that trees on this stock should have support.

The McIntosh orchard planted in 1928 grew better than last year. Comments on the mulched areas are made in the report on the Mulching Project. As measured by trunk diameter, McIntosh trees on Malling XII, XV, and XVI and on their own roots are now larger than the trees on seedling roots; trees on Malling X and XIII are somewhat smaller; and trees on Malling I, V, and VI considerably smaller. Trees on Malling IV are almost as large in trunk diameter and spread of top as those on seedling roots but are not as tall, indicating that this is a promising stock for fruit growers who wish to avoid tall trees.

The trees on various stocks in the 1939 orchard continue to grow about the same; little indication of dwarfing effect of the stocks has yet appeared. A few scattered trees bore apples. In midsummer leaf scorch and partial defoliation appeared. The symptoms suggested magnesium deficiency and an analysis of leaf samples supported this. The trees were given a liberal application of potash (with nitrogen) in the spring of 1941 and it has been shown that potash applications bring out symptoms of magnesium shortage. The situation will be studied further and steps taken to remedy it.

The diameter of the bulge or swell at the point of union and that above and below the union were measured in June. The diameter above the union always averaged smallest. The swell was larger with the stocks known to be dwarfing, and was influenced also by the scion variety. It is doubtful whether the size of the swell is of much significance in the performance of the trees. This work will be more fully reported elsewhere.

**Lethal Incompatibilities between Clonal Stocks and Varieties of Apples.** (J. K. Shaw and L. Southwick.) The above project is concerned with stock-scion combinations that may be useful in orcharding. There have appeared some combinations that fail sooner or later. We have been unable to make some of the flowering crabs grow on some of these clonal stocks. Cases are known in which comestible varieties fail. Deeming this situation worthy of study, a new project has been started in an effort to learn the reason for such failures.

**Tree Characters of Fruit Varieties.** (J. K. Shaw, A. P. French, O. C. Roberts, and L. Southwick.) This project has been carried on for many years. As new varieties are constantly appearing there seems to be no end in sight of a need for such work. Varieties of apple, pear, plum, cherry, and peach desired for observation are maintained in the nursery. The usual inspection of nurseries for trueness to name was made, but certification under the auspices of the Massachusetts Fruit Growers' Association was discontinued this year. If trees are kept true to name in the nursery row, the chances of a grower getting trees not true to name is small; and it was felt that the relatively expensive certification was not worth while.

**The Genetic Composition of Peaches.** (J. S. Bailey and A. P. French.) Special attention was given to the inheritance of blossom characters. Results indicate that blossom type (showy or nonshowy blossoms) is controlled by one pair of genes (Shsh), with the nonshowy type dominant, and that blossom size is controlled by one or more other pairs of genes. This work will be reported in the *Proceedings of the American Society for Horticultural Science*.

**Comparison of Cultivation and Sod in a Bearing Orchard.** (J. K. Shaw.) This project was continued as in the past but a new project referred to elsewhere was started on one of the complete-fertilizer plots. Another plot is used for the mulching experiment and is referred to under that project. The remaining five plots continue to indicate that on this soil a balanced fertilizer is now necessary. It suggests that the fruit grower who is using nitrogen alone as a fertilizer should watch for indications of a shortage of other elements. As long as nitrogen alone results in satisfactory performance of the trees it should be continued, but any symptoms of shortage should be promptly diagnosed and the deficiency supplied.

**Comparison of Cultivation and Heavy Mulching for Apples.** (J. K. Shaw.) The two small plots where heavy mulching was begun in 1922 continue as reported last year. The mulch material decays rather slowly and bids fair to last several years without additional applications. The trees continue to grow and bear well although grass grows vigorously up through the mulch.

Additional mulch was applied to plot 3 in the cultivation-sod orchard. The material was weighed this year. It amounted to 4225 pounds applied to 10 trees or about  $5\frac{1}{2}$  tons per acre. Probably this amount applied annually is more than is economical. Rootlets are much more abundant just beneath the mulch than in surface areas under cultivation or sod. Doubtless there are three conditions that would favor such root development: (a) better and more uniform moisture supply, (b) more readily available nutrients, and (c) better aeration. The growth on these trees this summer was remarkably good and the crop was the largest of any of the seven plots in the orchard. When the mulching was begun four years ago nitrogen must have been very low and the cover crop was negligible. The mulch was applied to almost bare soil. Yet there never have been any signs of nitrogen depression following these liberal applications of waste hay. The trees immediately improved in vigor and production and continued to do so in successive years. No fertilizer, other than the mulch, has been applied for twenty years.

The two plots in the McIntosh clonal stock orchard received additional mulch this second year. The material weighed 13,300 pounds or about  $6\frac{1}{2}$  tons per acre. This again is an excessive amount and will be reduced in the future to see if equally satisfactory results can be obtained. The rest of the orchard was seeded in August 1940, to a mixture of red, alsike, and Ladino clovers. A good stand was obtained and now consists mostly of Ladino clover. The clover areas (about two acres) were fertilized with 150 pounds nitrate of soda and 200 pounds nitrate of



potash with an additional 2 pounds nitrate of soda per tree applied under each tree, no clover growing there. The mulched trees received no other fertilizer. The two lots of trees look about the same. Root development beneath the mulch is similar to other mulched plots.

**The Effect of Orchard Mulches on the Plant Nutrients in the Soil.** (J. K. Shaw in cooperation with the Chemistry Department.) This is a new project. Previous work has shown that nitrates and replaceable potash abound in orchard soils beneath a hay mulch. We wish to know whether this is also true of other mineral nutrients and whether it is due solely to nutrients in the mulch or to soil conditions brought about by mulching. Two 30-year-old McIntosh trees growing in cultivation were mulched with hay, two with glass wool, which may be expected to produce similar soil conditions, and two are continued in cultivation. Two trenches were dug under each tree and soil samples at several depths were taken. These are now being analyzed to determine total and available nutrients. Similar samples will be taken one or more times each year and analyzed.

#### **Studies of Varieties of Fruits.** (J. K. Shaw and Staff.)

*Apples.* Milton trees bore a good crop this year. As trees get older the irregular shape of the fruit is less pronounced than is that of young trees. Milton is larger, of more attractive color, and later than Early McIntosh; the tree is of far better growing habit and begins to bear earlier.

*Sweet Cherries.* There are no commercial sweet cherry orchards in Massachusetts; yet it would seem that growers in this State might compete with those who ship in considerable quantities of fruit. Leaf spot and brown rot can be controlled easily. The two most serious difficulties are winter injury to the trees and depredations by birds. Proper choice of site and soil and suitable soil management will go far towards preventing winter injury and it is doubtful whether birds would be very troublesome in orchards of an acre or more. Birds harvested most of the blueberries in two small unprotected plots, but when two acres were planted the mischief of birds became insignificant. It has been suggested that captive hawks or even stuffed hawks might scare away birds. In a limited trial in one of our small blueberry plots a live hawk seemed to keep birds away. It should be remembered that only certain species may legally be kept in captivity.

We have grown in the nursery about twenty-five varieties of sweet cherries and most of them are also in our orchard though not all are in bearing. A few notes on some varieties are here given:

Bing is a dark, red cherry often in our markets. It is meaty, of attractive appearance and good quality, with a small pit. It is not very productive.

Black Republican is another dark cherry of good quality but not very large. It is commonly used only as a pollinator.

Dikeman is small, rather sour and of not very good quality. It is not to be recommended.

Giant is a large, dark cherry, inferior in quality to others of its class.

Napoleon is the yellowish Royal Ann of the Pacific Coast and our markets. It is perhaps the best light colored sweet cherry but not as hardy to cold as other varieties.

Schmidt is one of the best dark cherries, of very good quality and fairly hardy. It is recommended to plant with Windsor as a pollinating variety. Nelson is very similar to if not identical with Schmidt. Paul Rose is a yellow bud sport of Schmidt with a red line down the suture. Neither is superior to Schmidt.

Windsor is the best sweet cherry for Massachusetts. It is dark red, hardy, productive, and of very good quality.

Gold or Starks Gold was very productive and hardy at first. Later the trees were killed apparently by winter cold. It is poor in quality.



Sweet September is a late yellow cherry which 's now being advertised by some nurserymen. It appears to be too tender to cold for Massachusetts.

*Peaches.* Duke of York. An old English peach recently brought to the attention of American peach growers. It is an early white-fleshed peach but is unattractive, poor in flavor, has soft-melting flesh, and is semi-cling. Its value in Massachusetts is very doubtful.

Goldeneast. This is a fine, large, freestone, attractive, yellow-fleshed, mid-season peach of very good flavor. It looks very promising.

Redrose is an attractive white-fleshed, late, freestone peach. Flavor was not very good.

New Jersey 102. A medium-season, yellow-fleshed, freestone peach of good quality but not outstanding.

New Jersey 105. A yellow, late, freestone peach; quality only fair.

New Jersey 108. A late, yellow-fleshed, freestone peach; quality poor. Probably ripens too late for Massachusetts.

New Jersey 109. A late, white-fleshed, freestone peach of fair flavor. Not attractive. It may be a little late for Massachusetts in some years.

New Jersey 111. A late, yellow-fleshed, freestone peach, attractive but of only fair flavor. Heavy crop for small tree.

Sungold. A medium-late, yellow-fleshed, freestone peach of very fine flavor and attractive. It has a thick, tough skin and should ship well. The tree is dwarfish and spreading like J. H. Hale.

*Grapes.* In recent years the New York Experiment Station has bred and the New York Fruit Testing Association introduced many new varieties of grapes. The following varieties are all of this origin:

Erie is a good, early blue grape. The bunch is poor and it is self-sterile. There are better grapes of its season. It seems to be no longer offered by the Fruit Testing Association.

Hanover, Sheridan, Urbana and Wayne all matured fairly well this year but usually our season is too short for them. It is doubtful if any of them should be planted here except under conditions most favorable for maturity.

Several varieties not yet named were fruited. Number 12236 (red) and 12238 (reddish blue) have received the most favorable comment and are regarded as promising. Concord Seedless (blue) and numbers 9975 (blue), 11361 (reddish blue), 11412 and 11679 (both green) appear less promising.

*Raspberries.* Marcy is still free from mosaic disease, of good quality but rather soft for shipment. It is more desirable than Taylor but it is doubtful if it can replace Latham as a commercial variety.

Marion is a purple raspberry with the undesirable color of that type. It is thought to be superior to Sodus and worth trying if one wants a purple raspberry.

Tahoma appears to be undesirable. The berries are small, soft and sour.

Taylor suffers severely from Mosaic, and its quality is inferior to Marcy.

Among five numbered seedlings from Geneva, No. 13618 seemed most promising. Numbers 5371, 5548, 13108 and 14685 were, for various reasons, considered to be of doubtful value.

*Blueberries.* Concord. This variety produced very attractive, firm, fine-flavored berries in 1941. There was no tendency to crack after rainy periods. Most berries were large but size was somewhat variable. The scar is large and watery with a tendency for the skin to tear.

Dixi is yet too young to give a good idea of the variety. Bush appears vigorous but yields have been light. Fruit late, large, of good flavor, picks easily, but has a large watery scar.

Jersey. Large, attractive berries make this look like a good variety. The bush is vigorous and yields well. Flavor is excellent if the berries are allowed to ripen well on the bush but very sour if picked a day or two too soon.

June. This variety has improved in growth since the soil was drained, but growth is still weak in comparison with other varieties. Since it is earlier than Cabot, it might have a place for home garden use or roadside stand trade.

Pemberton. This variety continues to look promising because of large size and attractiveness of berries and good yield. Fruit has excellent flavor but the scar is large. There was very little cracking after rainy periods.

Scammell. This variety is probably not adapted to this climate. Leaves are small and growth is not vigorous. Berries are large during first of season but late berries are small. Flavor is good. Berries are firm but they cracked after rainy periods.

Stanley. The performance of this variety was disappointing this year. Growth was poor and yield very light.

Wareham. Berry size was unusually large this year—90 per cup at the start of the season—and held up well. It has a distinctive wild blueberry flavor that some people like. The bush is open and the fruit clusters are small and open, making picking easy. The scar is small. It yields well, but the dark-colored fruit lacks attractiveness. This year it became soft and cracked very badly after rains, and kept poorly in storage.

**Fruit Bud Formation in the Strawberry.** (R. A. Van Meter.) Differential mulching experiments brought this study to an end with the harvesting of the 1941 crop. Results are now being summarized.

**Nature of Winter Hardiness in the Raspberry.** (R. A. Van Meter and A. P. French.) One of the serious difficulties of the raspberry grower in Massachusetts is winter injury to the canes and buds. The occurrence is erratic and unpredictable. Little seems to be known about the causal conditions. A study will be made of the rest period, vegetative condition, and chemical composition of the plants in their relations to winter injury. Several seasons' work are likely to be necessary before definite results can be reported.

**Storage of Apples in Modified Atmospheres.** (L. Southwick and O. C. Roberts in cooperation with Department of Engineering.) Experiments with 40-quart milk cans as gas-tight containers were continued. Attempts were made to maintain definite atmospheres in the cans by daily flushing with nitrogen, by taking out excess carbon dioxide, and by controlling ventilation. The cans were filled on December 2, 1940, with about 35 pounds of rather mature, wrapped McIntosh apples and sealed immediately. These apples at 40° F. generated carbon dioxide at the approximate rate of 2.5 milligrams per hour per kilogram of fruit. Where a sodium hydroxide scrubber was used to wash out the accumulations of carbon dioxide, the oxygen in the cans was reduced to below 3 percent in 8 to 10 days. Complete oxygen depletion was greatly hastened when cans were flushed with nitrogen every day or two.

It was difficult to maintain the desired constant atmospheres in these cans by the methods employed. Since the apples occupied as much as 50 percent of the total space in the cans, respiratory activity itself caused rather abrupt changes in the composition of the atmosphere. Furthermore, a very brief washing period reduced the carbon dioxide content to practically zero. The carbon dioxide increased to an average of 10 percent in the cans between scrubblings. Oxygen percentages varied much less widely around the desired 2 percent level. It was somewhat difficult to keep the oxygen level sufficiently high to prevent anaerobic

respiration unless ventilation was provided. One tight can was left undisturbed with a subsequent  $\text{CO}_2$  accumulation of over 60 percent of the total atmosphere.

Through controlled ventilation, one can was operated approximately on the English system of 10 percent oxygen and 11 percent carbon dioxide. With an open 3/8-inch vent near the base of the can, respiration at  $40^\circ$  reduced the oxygen below the 10 percent level. By controlling the amount of leakage through a similar hole at the top of the can, the desired atmosphere was maintained fairly well. Only a very small top opening was needed to allow sufficient air leakage to counterbalance oxygen utilization.

On March 1, one can was opened. The atmosphere in this can had been maintained at less than 1 percent of oxygen with the  $\text{CO}_2$  averaging around 12 percent. The apples were in poor condition with scald, skin ruptures, and some internal breakdown. The more highly colored apples were in the best condition both in appearance and eating quality. The flesh was rather soft. A slight alcoholic taste was evidence of anaerobic respiration.

On May 1, another can was opened. The oxygen content of this can had averaged about 2 percent with the  $\text{CO}_2$  ranging between 3 and 10 percent. Most of the apples were in good condition with excellent color and no evidence of scald or internal breakdown. There was some soft rot and mold where apples had been injured. Quality was fairly good. A duplicate can was opened two weeks later and here, also, the apples were in good condition though the quality was mediocre. A rather high acidity was a contributing factor.

The can which was operated on the English system was examined on May 13. The oxygen level had varied between 8 and 15 percent. With this system, the sum of the oxygen and  $\text{CO}_2$  always equals about 21 percent. There was no scald, core breakdown, or rot, but quality was rather poor.

Where flushing with nitrogen was utilized and a very limited amount of ventilation provided, apples were still in good eating condition on May 13. The oxygen in the can had varied between approximately 2 and 6 percent and the  $\text{CO}_2$  between 2 and 12 percent. Just why this treatment gave the best results is not clear unless it was due to the frequent change of atmosphere in the can. The apples (at  $40^\circ$  F.) were better than checks kept at  $32^\circ$ – $33^\circ$  F.

These tests indicate that more uniform control of the atmosphere in a modified-atmosphere storage room is a requisite to the successful operation of such a room. Undoubtedly, the wide fluctuation in the composition of the atmospheres in the cans was a determining factor in lowering eating quality.

The storage room which was "gas-proofed" in 1940 was not sufficiently tight to allow respiration to reduce the oxygen to the desired 2 percent level. A contributing cause of this failure was the fact that brine coils and the shape of the room allowed for only partial filling. This room was opened for inspection at 10 a. m. on February 24 and closed again at 5 p. m., resulting in a total loss of the artificial atmosphere. The oxygen was again lowered to around 10 percent which proved to be the minimum obtainable. The room was opened on March 24 and the fruit placed in another room at  $32^\circ$  F. The Wealthy and Gravenstein apples were past good eating condition; Cortland were fair to good; Delicious were very firm and in excellent condition. Golden Delicious were also in excellent condition and, where individually wrapped, these fruits showed no shriveling. McIntosh comprised the bulk of the apples. These were fairly ripe but not too much so for immediate use. Quality was good and somewhat better than that of similar apples stored as checks at  $32^\circ$  F. (Checks stored at  $40^\circ$  F. in normal air showed internal breakdown.) There were considerable differences between different lots of fruit. In general, the late picked McIntosh had the best quality. High color was associated with high quality. Some rot was in evidence on individual fruits. Many apples did not hold up well at room temperatures, largely because



of overmaturity. Those kept at around 34° F. retained fair eating quality for at least a month. A few fruits subsequently split open.

During the summer certain leaks in this room were corrected, the coils were removed, and a small automatic blower system was installed. This arrangement allowed for the storage of 100 additional boxes. With the 300 bushels, mostly McIntosh, this room is now considered sufficiently full and gas-tight for effective operation as a modified-atmosphere storage room. It was filled and temporarily sealed up in October but later the apples were removed in order that some alterations might be made. It was again filled and sealed on November 27. Previous leakage tests indicated less than 5 percent leakage per 24 hours. At the time of this writing (December 20), this storage is performing satisfactorily. The oxygen level is now down to 2 percent.

It is entirely possible that modified-atmosphere storage, especially for McIntosh, may shortly displace in some degree conventional cold storage methods. It seems to offer advantages that are very desirable and perhaps necessary for the continued prosperity of the industry.

**Study of "Bud Sports" of the McIntosh Apple.** (J. K. Shaw and L. Southwick.) Trees of 21 so-called "bud sports" were planted in the spring of 1941. Three of these have been propagated for several years, while the others are selections from orchard trees. Half of these are on dwarfing and half on vigorous stocks. The purpose of this planting is to maintain the selections and to see what color type of apples they bear. Most of them are supposed or known to be non-striped strains.

Trees of six forms are ready for orchard planting next spring for the purpose of measuring accurately not only the color type of the fruit but also the vigor, productiveness, and other characteristics of both tree and fruit.

**Nutrition of the High bush Blueberry, Especially in Relation to Soil Reaction.** (J. S. Bailey.) Mixing lime with the soil reduced the growth of blueberry plants. Mixing 5 percent peat with the soil reduced slightly the bad effects of the lime. This work was reported in the *Proceedings of the American Society of Horticultural Science* 38, 1941.

An experiment was started in the spring of 1941 to compare the value of cow, horse, and hen manure as fertilizer for blueberries. Manures have been thought to be harmful to blueberries, especially when applied on soils with a pH above 5. To date the plants look fully as good as those fertilized with mineral fertilizer.

**Blueberry Culture.** (J. S. Bailey.) During the summer a diversion ditch was constructed around the experiment station blueberry planting so that trouble from erosion should be reduced to a minimum.

The plantings yielded a little over 3000 quarts as compared with 2000 quarts in 1940.

Experiments to control the cranberry fruit worm on blueberries by dusting were continued. Because so few worms were present, even in the checks, the results were not conclusive.

The budding work of 1940 was a complete failure. The bud shields stuck to the stocks but the buds died. This work was repeated in 1941. The buds were set low and protected for the winter by piles of sawdust.

Since the war has cut off the supply of imported peat which has been quite generally used for propagating blueberries, a substitute must be found. A comparative test of several domestic peats was started in the spring of 1940. Nothing which is superior to the imported peat has been found. A leaf mold from Massachusetts and a sphagnum peat from Maine compare favorably with the imported peat.



A light supplementary application of ammonium sulfate about June 7 was given all the blueberries except those in the manure test. The improved appearance of the plants and the increased yield over previous years indicate that this was a good practice.

Bulletin 358, Blueberry Culture in Massachusetts, was revised.

**Premature Dropping of McIntosh Apples.** (L. Southwick.) Work on this project largely concerned investigations with "hormone sprays." Some chemicals such as naphthalene acetic acid and certain of its salts, naphthalene acetamide and some others, have been shown to delay natural drop of apples at harvest when applied in dilute spray solutions. These chemicals and several commercial proprietary compounds employing these active ingredients were used in field tests in 1940 and 1941. Bulletin 381, published in February, 1941, summarized the results of experimental work conducted in 1940 and in it the authors attempted to evaluate the method of "hormone spraying" especially in relation to McIntosh. Further tests in 1941 revealed no very different results. There was some evidence that under certain conditions, drop-control sprays on McIntosh were not so effective as in 1940. Many check trees dropped comparatively little this year. In most cases, however, the preharvest drop from sprayed trees was less than that from check trees in the same block. Some typical percentage drop comparisons, sprayed and unsprayed, follow: 3.7 and 14.5 percent; 12.9 and 20.2 percent; 2.3 and 7.5 percent; 10.2 and 13.4 percent; 11.6 and 21.4 percent; 7.3 and 18.5 percent; 13.9 and 13.4 percent. It is apparent from these figures that degree of control was not consistent.

There is some indication that the temperature at the time of application may be important. Possibly fruit growers should wait for temperatures above 60° F. before applying a drop-control spray. A more definite statement on this point must await further experiments.

A limited test with Milton indicated little benefit from spraying. The sprayed trees dropped 31 percent of the total crop compared with 34.6 percent from the check trees.

Results again demonstrated the desirability of using standard strength sprays with McIntosh. Weaker sprays were usually less effective. Doubling the standard strength increased the effectiveness of applications. How much improvement in drop control would be required to offset the increased cost of stronger sprays is problematical and depends on several factors. It can be stated with some assurance, however, that the so-called standard strength of "hormone sprays" should not be reduced with McIntosh in this State.

The use of special stickers or summer oil seems to merit some consideration. Theoretically, these materials should tend to improve coverage. Actually, the benefits from their inclusion in hormone sprays have been variable. Usually, drop control has been somewhat better although in some cases improvement has been negligible. It is at least certain that spreaders and stickers are not effective substitutes for good coverage.

Dusts were tried this year for the first time. These were made up by two commercial concerns and were compared with spray applications. In about half the tests, dust was only slightly inferior to spray in lessening pre-harvest drop. In the others, dusting was not effective. It is true also that spraying was practically ineffective in some cases. The heavier applications of dusts (4 pounds per tree) seemed more effective than lighter dosages. Until further evidence is at hand, the use of hormone dusts by growers is recommended for trial only.

### Miscellaneous Work

**Soil Acidity in the Orchard.** Lime was applied to a Sudbury orchard in which aluminum toxicity was suspected, as mentioned in the report of last year. It appears that both grass and trees were improved by the treatment. With the increasing use of wettable sulfur the danger of injuriously high acidity becomes greater. Not only is there danger of aluminum toxicity, but nitrification in the soil decreases as the soil acidity increases.

**Lime and Phosphorus in Planting Trees.** We have as yet no evidence that phosphorus is directly beneficial to apple trees on our soils; we know that it is readily fixed in the soil and it follows that orchard applications may not pass into the relatively deep-rooted apple trees. An orchard of 36 McIntosh trees of a single strain on three clonal stocks was planted in the spring of 1941. One third of the trees were treated with 10 pounds dolomitic limestone, one third with 5 pounds triple superphosphate, and one third were untreated. The materials were placed in the bottom of the planting holes and well mixed with the soil. As measured by trunk diameter increase, the trees treated with lime grew most, those treated with phosphorus least, while the untreated trees were intermediate.

**Weed Killing.** The attempt to get rid of wild cherries, particularly choke cherries, around the peach orchards was continued. A new weed killer, ammonium sulfamate, was tried. It looks very promising. Used at the rate of  $\frac{3}{4}$  pound per gallon water, one application was enough to kill small choke cherries and kill or badly damage black cherries. Chlorate weed killers used at the same strength were not so effective on choke cherries and were ineffective on black cherries.

**Ethylene Dichloride Emulsion for Control of Peach Tree Borers.** Because of reports of damage from the use of this material in other sections, it is being thoroughly tested in the station orchards. It has been used in 1939, 1940, and 1941 in one orchard and in 1940 and 1941 in several others. Applications have been made at 15-day intervals during the fall. The emulsion has been used (1) according to directions, (2) at slightly higher concentrations, and (3) in slightly larger quantities, than recommended. Only one case of injury has occurred; some very vigorous late-growing suckers from the base of some trees were injured when applications of the emulsion at the concentration for three-year old trees was applied. This was an overdose for the year-old suckers. Unseasonably hot weather following the application may have had an effect. Injury has never occurred when applications were made according to standard directions.

**Sawdust Mulch.** In the summer of 1938, a sawdust mulching program was begun in a small block of bearing apple trees. An average of about 4 inches of sawdust was placed under alternate trees to determine the effect of sawdust on subjugation of sod, on soil nutrients and acidity, and finally on tree growth and production. The sawdust had little effect in subduing the grass, which proceeded to grow apace throughout the summer and fall. Unlike hay or straw, which tends to mat down, sawdust does not tend to smother grass. No additional applications were made during the next three years. Neither deleterious nor particularly favorable effects on soil or tree have been observed to date.

In November and early December of this year, a considerably greater amount of sawdust was applied to the same trees. This time, however, the sod on half of the area under the branch spread was taken up and the soil shaken out. The other half was left in sod. Sawdust to an average depth of 6 inches was applied over the whole area. It is intended to determine the comparative feasibility of using a sawdust mulch on cultivated soil and on sod in a bearing orchard.

## DEPARTMENT OF POULTRY HUSBANDRY

## R. T. Parkhurst in Charge

**Broodiness in Poultry.** (F. A. Hays.) A number of specific facts have been established in this study of the inheritance of the broody instinct in Rhode Island Reds. Some of the most significant findings are the following. The length of the non-productive period associated with broody behavior remains rather constant at about fifteen days. Degree of broodiness as measured by the number of broody periods is governed by inheritance. The time of appearance of the broody instinct in the life of a female is highly variable. In flocks bred to eliminate the broody instinct, the onset of broody behavior in individual females has been about 57 percent in the first laying year, 34 percent not until the second laying year, and about 8 percent not until the third laying year. These three classes of females when used as breeders gave about the same percentages of broody daughters. The selection of female breeders that did not exhibit the broody trait during their first two laying years was effective in reducing the incidence of broodiness in the flock. There is no evidence of sex-linked inheritance.

At present efforts are directed toward the establishment of an entirely non-broody line by applying all of the information now in hand.

**Statistical Study of Heredity in Rhode Island Reds.** (F. A. Hays and Ruby Sanborn.) This project is devoted entirely to the preparation and analysis of experimental data used for publication. During the year the following papers have been prepared: The Importance of Length of Incubation Period in Rhode Island Reds, Bulletin 384; Breeding for High Viability, a study covering seven years, has not yet been published; A Preliminary Study of Molting Behavior, covering three years, has not yet been published; and A Study of Variation in Egg Weight, covering five years, is now in preparation.

**A Genetic Study of Rhode Island Red Color.** (F. A. Hays.) This study has to do with the genetic complex concerned in the inheritance of Rhode Island Red plumage and possible relationships between characters affecting fecundity and plumage color. Two lines of birds are being carried, one breeding true for late sexual maturity and the other selectively bred for early sexual maturity. There is some evidence that one or both of the dominant genes for early sexual maturity affects plumage color. The relation between the red of the Rhode Island Red plumage and the buff of the Orpington is also being studied.

**Rate of Feathering in Rhode Island Reds.** (F. A. Hays.) This experiment is concerned primarily with the genetic aspects of rapid and slow chick feathering. To study this problem three lines have been developed with respect to rate of chick feathering; namely, a rapid-feathering line produced exclusively by the use of breeding males that showed complete back feathering at eight weeks of age; a slow-feathering line bred entirely from sires showing the absence of back feathering at eight weeks of age; and a check line bred primarily for high fecundity, with some of the sires rapid feathering and some slow feathering.

In the spring of 1941 the seventh generation was produced in the three lines, and gave the following percentages of rapid-feathering sons at eight weeks: line 1, 100; line 2, 10; and the check line, 84. The chicks were also classified for the sex-linked gene for rapid feathering at twelve days of age. The males in the three lines gave the following percentages with the sex-linked rapid-feathering gene: line 1, 49; line 2, 0; and the check line, 6. An attempt was also made to separate the rapid- and slow-feathered females by grading the feather growth in the back region at four weeks of age.

All data available indicate that in Rhode Island Reds the sex-linked gene for



rapid feathering may or may not be present in rapid-feathered stock. There is, however, a definite sex difference in the rate of feathering in the dorsal region.

**The Effectiveness of Selective Breeding in Reducing Mortality in Rhode Island Reds.** (F. A. Hays.) This is a cooperative project with the Regional Poultry Research Laboratory, East Lansing, Michigan. In the spring of 1934 a project was begun to test in a small way the effectiveness of selective breeding in reducing mortality in Rhode Island Reds.

The foundation stock consisted of pedigreed birds that had been bred for characters associated with high fecundity since 1916. During the first five years females alone were kept to the age of 18 months. Beginning with the sixth generation, hatched in 1939, both males and females were retained to the age of 18 months. An attempt has been made to establish two lines, one for low mortality and the other for high mortality. Breeding males and females 24 months of age were used as breeders and the sole basis of their selection was the mortality rate of their sisters during their first laying year. A check line consisted of birds bred for high fecundity. Inbreeding in both lines was avoided by the constant use of males drawn from the check group but selected on the mortality basis. Limited facilities available permitted the production of about 100 birds in each of the mortality lines, and since 1939 about equal numbers of males and females have been carried to 18 months of age. Complete mortality records have been kept and post-mortem examinations have been performed by the Department of Veterinary Science.

The limited data now available indicate in general that selective breeding was effective in small groups in reducing the mortality rate from the miscellaneous diseases and disorders appearing under our conditions.

**Genetic Laws Governing the Inheritance of High Fecundity in Domestic Fowl.** (F. A. Hays and Ruby Sanborn.) Many phases of this problem have been studied and reported upon. At the present time special attention is being given to the genetics of intensity and winter pause. These two characters have a rather complex inheritance and their interactions with other characters are very significant. Possible interactions between genes affecting intensity and genes affecting egg size are being given close study. The mortality problem as affected by selective breeding is also being given constant attention.

Recent findings indicate that chicks emerging early from the shell are likely to be superior from the standpoint of fecundity; that heavy body weight in both males and females at six months of age is a significant criterion of future low mortality; and that selective breeding for characters affecting egg production has not reduced the viability of the stock. Reducing the variability in egg production is a slow process because of the complex nature of inherited factors and environmental interactions.

**A Study of Fertility Cycles in Males.** (F. A. Hays.) Histological studies of testes from males in a wide age range, taken throughout a two-year period, indicate that both age and season affect the rate of spermatogenesis. There is definitely a cyclical behavior in males with respect to their fertility. Preliminary breeding tests have not indicated that fertility is governed by inherited factors. This problem of possible inherited factors is being studied further along with environmental factors that may be in operation.

**Physiological Relationships Between Molting Behavior and Fecundity Characters.** (F. A. Hays.) Bi-weekly individual molt records are being continued on a fourth series of males and females from parents with known molt records. The first breeding stage of this project began in the spring of 1941. Two lines



were started, the first from females laying but few eggs during molt and the second from females laying for a relatively long period during the molt. Preliminary studies over three years indicate that the ability to lay eggs and molt simultaneously is a highly desirable trait. The change in body weight of males and females during the annual molt is not very significant. Males already used required an average of about 94 days to shed their wing primaries while females averaged about 119 days. Some females lay very few eggs during this period while others lay up to 40 or 50 eggs. Good females should shed at least three primary wing feathers before laying stops. Completion of wing molt in December appears to be desirable from the standpoint of first-year egg production.

**Miscellaneous Genetic Studies.** (F. A. Hays.) Linkage studies include genes for shank feathering, comb form, and mottled ear lobes in Rhode Island Reds. An effort is also being made to isolate the sex-linked gene for early sexual maturity. A new method for separating sexes in Rhode Island Red chicks is being studied and offers some possibilities. For auto-sexing, a gold-barred bird is being developed on a limited scale.

**The Use of Crab Meal in Poultry Rations.** (Raymond T. Parkhurst and Marie S. Gutowska with C. R. Fellers of the Department of Horticultural Manufactures cooperating.) In broiler production studies, Red-Rock cross chicks were used and comparisons involved the 1940-41 New England College Conference starter as the basal ration, the basal ration with 5.5 percent crab meal replacing 2.5 percent fish meal, the basal ration with 5.5 percent crab meal replacing 5 percent milk and 2.5 percent fish meal, and the basal ration with 3 percent fish meal replacing 5 percent of dried skim milk. The mineral contents of the rations were adjusted. There were no significant differences in growth, mortality, feed efficiency, feathering, or pigmentation.

When crab meal replaced fish meal on an equal-protein basis (4 pounds for 2.5 pounds) in the Massachusetts complete all-mash laying ration, there were no significant differences in egg production, weight of eggs, feed efficiency, yolk color, albumen quality, fertility, and hatchability. The egg production averaged higher in the fish meal group, based on the birds that lived, but fewer birds died in the crab meal group; with the result that total production, total income, and the feed cost per dozen eggs were practically the same for the birds on the two rations. The results to date show that crab meal is a satisfactory ingredient in poultry rations and can replace fish meal on an equal-protein basis. Further comparisons of these feeds are in progress.

**The Manganese Requirements of Laying Hens.** (M. S. Gutowska and R. T. Parkhurst.) The effect of the addition of manganese to complete all-mash laying rations was investigated from a practical standpoint. Forty-eight Rhode Island Red pullets were kept on a basal all-mash ration for 12 lunar months (2 periods each lasting 6 lunar months). The two high-manganese groups received in their diets 76 and 61 parts per million of manganese; the two low-manganese groups, 17 and 24 p. p. m., respectively. The data showed no appreciable differences in egg production, feed efficiency, fertility, hatchability, and livability between the compared groups; but the shell-breaking strength of eggs laid by the pullets on high-manganese rations was significantly greater than that of eggs laid by birds on the low-manganese rations, although the shell texture was not unsatisfactory in the latter groups. It was concluded, because all-mash laying rations containing as little as 17 and 24 p. p. m. of manganese did not produce manganese deficiency symptoms in laying hens in a period of 12 lunar months, that even these levels in laying rations can be considered satisfactory from a practical viewpoint.

**The Effect of an Excess of Calcium in the Diet.** (M. S. Gutowska and R. T. Parkhurst.) The results of this experiment showed that an excess of calcium in the ration of laying hens lowered the production value of the diet, and that 3.95 percent of calcium in the diet of laying hens having a normal dietary level of phosphorus and ample vitamin D intake was excessive. However, there was no significant difference in the egg shell breaking strength, the average egg weight, and the fertility and hatchability of eggs between the groups of birds receiving the varying levels of calcium.

The importance of a control of the mineral balance of laying rations by means of chemical analysis at regular intervals is suggested.

**The Value of Pulverized Calcite Flour as a Source of Calcium for Laying Hens.** (M. S. Gutowska and R. T. Parkhurst.) The object of this experiment was to compare qualitatively two rations with different sources of calcium: pulverized plain calcite and oyster shell meal, at the same quantitative level. The manganese content of the rations was estimated to be close to the assumed optimum for laying pullets.

The data obtained from two flocks of 24 Rhode Island Red pullets during 12 months showed no significant differences in production, body and egg weight, feed efficiency, egg shell breaking strength, hatchability, and fertility. The egg quality was equal in the two flocks.

It was concluded that pulverized plain calcite is as good a source of calcium as oyster shell meal for laying pullets; but its biological value as a mineral supplement for laying hens is not higher than that of oyster shell meal.

**The Phosphatase Activity as a Factor of Calcium Deposition and Egg-Shell Formation.** (M. S. Gutowska and R. T. Parkhurst, with the cooperation of E. M. Parrott and R. M. Verberg of the Chemistry Department.) Phosphatase activity as a factor of shell formation is studied by the determination of plasma and oviduct phosphatase activity. Four groups of hens, good and poor producers, with good and poor egg shell, are being compared in this regard. The phosphatase activity is determined according to a modification of King-Armstrong method.

**Electric Brooding.** (W. C. Sanctuary in cooperation with Professor C. I. Gunness of the Engineering Department.) The use of soil cable under 4 inches of sawdust litter materially reduced moisture content of litter, when used continuously, but at an excessive cost. The use of insulation plus restricted ventilation also reduced the moisture content of the litter materially, but not so much as the continuous use of the soil cable. The use of damp (40 percent moisture) sawdust from the start of brooding produced no deleterious results except for a large number of crooked toes thought to be due to cold floors. Because of high moisture content, the litter froze into a solid block on cold nights.

**Combining Meat and Egg Production.** (W. C. Sanctuary and J. H. Vondell.) The standardization of body weight in Barred Plymouth Rocks at 6 pounds by December 1 has been well established. The 1938 generation had a mean weight just below 6 pounds. The generations of 1939 and 1940 had a mean weight just a trifle above 6 pounds. There has been some improvement in meat quality as measured by fleshing upon the breasts at 8 weeks of age and later as adults. One adult male of the 1941 generation has approached the extreme "broad-breasted" type now produced in one variety of turkey. Egg production has improved also, three 300-eggers having been produced in the last two years largely because of improvement in intensity (rate) of production.

**Sexing by Down and Shank Color.** (W. C. Sanctuary.) The sexing by down and shank color of 948 College pedigreed Barred Rock chicks was done with a 95.36 percent accuracy compared to a 95.15 percent accuracy by the vent process method with the same chicks. The chicks were first judged by the down and shank characteristics.

**Restricted Feeding on Range.** (J. H. Vondell.) At 10 weeks of age, one half of the College Barred Rock chicks was placed on a restricted plan of feeding, while the remainder continued on the free-choice feeding of mash, oats, and corn.

The restricted plan consisted of feeding mash and oats until 10 a. m., when the hoppers were closed and no feed given until the 4. p. m. allotment of whole corn. The pullets were housed September 12 and both lots were placed on full feeding. The restricted plan resulted in a saving of 1.52 pounds of feed per chicken during the 15-week period. At 6 months of age the restricted and full-feeding lots weighed exactly the same, 5.85 pounds. There was no difference in maturity as determined by age at first egg. The laying-house mortality to April 1 was practically the same for the two lots. Also, egg production was quite close: 57.86 percent for the full-feeding and 62.88 percent for the restricted lot.

These studies are being continued.

## DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

**Poultry Disease Control Service.** (H. Van Roekel, K. L. Bullis, O. S. Flint, and M. K. Clarke.)

1. *Pullorum-Disease Eradication.* During the 1940-41 season the laboratory tested 309 chicken flocks representing 527,328 birds and 538,589 tests. The percentage of reactors (0.09) was the lowest in the twenty-one-year testing period. Of the total 478 reactors, the bulk was identified in one flock.

Testing service was rendered to flock owners in 11 counties. Middlesex and Worcester counties led in the number of birds tested. No reactors were found in Barnstable, Essex, Hampshire, Plymouth, and Worcester counties.

Five flocks which were non-reacting the previous year revealed infection during the 1940-41 season. In two instances a plausible explanation for the infection was obtained. In all instances but one the percentage of reactors was very low, less than one-half of 1 percent.

Flocks tested for the first time revealed the highest percentage of infection. Among the flocks (41) tested for two consecutive years, no reactors were found. Among the 210 flocks tested for three or more consecutive years, representing 437,145 birds and 446,694 tests, 0.08 percent reactors was revealed.

Approximately 88 percent of the total birds tested was confined to 100 percent tested, non-reacting flocks (256). Forty-three flocks were partially tested and non-reacting, representing 28,874 birds. Ten flocks were classified as positive, representing 34,853 birds.

Of the total birds tested, 490,759 were females and 47,830 were males. The percentages of reactors were 0.08 and 0.17, respectively.

A total of 4,417 samples collected from fowl other than chickens was tested for pullorum disease. The species tested included turkeys (4,259 tests), pheasants (115), guinea fowl (22), geese (13), ducks (5), and quail (3). Reactors were detected in three of the 32 turkey flocks, but in only one instance was *S. pullorum* isolated. No reactors were detected among the other fowl tested.

The testing results indicate that Massachusetts is making progress in eliminating pullorum disease from its chicken and turkey breeding flocks.

2. *Diagnostic Service.* During the year, 2,264 specimens were examined in 533 consignments. Personal delivery of specimens was made in 335 cases. The specimens may be classified as follows: 1,878 chickens, 256 turkeys, 38 canine feces, 24 pheasants, 11 each of foxes and goat feces, 7 pigeons, 6 trout, 4 bovine semen, 3 each of crows, peafowl, and ruffed grouse, 2 each of bovine organs, bovine skin scrapings, calves, canine, equine nasal swabs, mink, rabbits, and sheep, 1 each of bovine rumen contents, canary, equine, and pork.

The incidence of the more common and important disease conditions observed in chickens during the past five years is as follows:

	1936-37	1937-38	1938-39	1939-40	1940-41	Total
Avian tuberculosis.....	1	1	3	1	1	7
Coccidiosis.....	35	64	97	82	63	341
Enterohepatitis.....	2	7	6	7	7	29
Epidemic tremor.....	8	35	22	19	12	96
Fowl cholera.....	11	3	16	12	13	55
Fowl coryza.....	5	2	1		3	11
Fowl paralysis.....	37	45	77	47	51	257
Fowl pox.....	8	30	21	7	9	75
Fowl typhoid.....	4	2	11	4	1	22
Infectious bronchitis.....	40	31	48	57	31	207
Infectious laryngotracheitis	12	9	19	14	13	67
Internal parasites.....	23	21	41	26	34	145
Kidney disorders.....	17	15	37	21	19	109
Leukemia.....	7	3	6	3	5	24
Nutritional encephalomalacia	1	7	13	8	6	35
Paratyphoid.....	1	2	3	1		7
Perosis.....	4	2	4	3	3	16
Pullorum disease.....	39	46	49	32	28	194
Reproductive disorders.....	22	14	20	21	17	94
Rickets.....	8	6	19	19	10	62
Tumors.....	53	46	79	53	66	297
Ulcerated gizzards.....	1	15	14	15	10	55
Unknown disease.....	9	11	24	26	33	103
Unknown pullet disease....	6	6	11	9	14	46

The 256 turkeys were received in 44 consignments. Paratyphoid, coccidiosis, enterohepatitis, and ulcerative enteritis were the conditions most frequently encountered. Pullorum disease was observed only once for the second consecutive year and these poults came from a source outside of the State. Pullorum disease was, however, established in a Massachusetts flock through necropsy of a reacting turkey. Swine erysipelas and fowl cholera were each identified once. This is the first time that fowl cholera has been recorded in a Massachusetts flock. *Capillaria contorta* was identified twice in one flock. This parasite produced symptoms in quite a number of birds in both instances.

*Capillaria plica* was observed in one fox. We are indebted to the Zoological Division, Bureau of Animal Industry, United States Department of Agriculture for identification of the parasites in the fox and in the turkeys.

Listerellosis was identified in a canary. All females (eight) in the aviary died within a two-week period. The males in a separate cage were not affected.

3. *Flock Mortality Studies.* These studies have been continued to obtain additional data on causes of adult mortality and to furnish information for genetics experiments. Necropsy examinations were made on 208 morbid and dead birds from the flock which was hatched in the spring of 1940 at the Experimental



Poultry Farm. There were 147 females and 61 males. A wide variety of diagnoses was made on these birds, but no unusual outbreaks of disease were noted. The mortality in this year's flock was widely distributed over the year, whereas the mortality in flocks hatched in previous years had a tendency to be concentrated in the late spring or just after the birds were more than one year of age. Cannibalism was materially reduced in this group of birds, whereas fowl paralysis and staphylococcosis were markedly increased.

4. *Salmonella Types Isolated.* The identification of paratyphoid organisms isolated from diseased specimens continued during the past year, and 21 were added to those previously reported. Eighteen were *S. typhi-murium*, one was *S. anatum*, and two (from different organs of the same specimen) appear to be a new type. These 21 strains came from six flocks. One strain was isolated from a pigeon and all others from turkeys (7 mature and 13 poults).

During the past year, 4104 turkey blood samples were tested for paratyphoid infection by the macroscopic tube agglutination test. An autogenous antigen of *S. typhi-murium* was used as a test fluid. While infected birds can be detected by such a procedure, the method can not be relied upon to eliminate the infection to the degree accomplished in pullorum-disease testing. Owners of flocks that are apparently free of this infection should investigate thoroughly the history of the source from which stock may be introduced.

We are greatly indebted to Dr. Philip Edwards, Department of Animal Pathology, University of Kentucky, Lexington, Kentucky, who identified these strains as to type.

5. *Avian Encephalomyelitis.* The infective agent was passed through chicks (intracerebral inoculation) 21 times during the past year and is now in its 125th passage since its first isolation. Its characteristics do not appear to have undergone any permanent change during the twelve months. An attempt was made to determine the presence of avian encephalomyelitis virus in the brain of adult birds which had exhibited typical symptoms of the infection as chicks. Six hens of this type were destroyed and brain suspension prepared from each for inoculation intracerebrally into baby chicks. In no instance did the brain suspension produce symptoms of avian encephalomyelitis. A suspension prepared from the ovary of one of the six birds also gave negative results when inoculated into baby chicks. The virus appears to lose its potency very slowly if stored at  $10^{\circ}\text{C} \pm$ . This conclusion is based on inoculation of three brain suspensions prepared 10/8/38, 4/12/39, and 8/24/39 and stored until 1/21/41. The oldest (stored 837 days) produced typical symptoms in 50 percent of the chicks inoculated; the next oldest (stored 650 days), in 67 percent of the chicks; and the most recent (stored 517 days), in 86 percent of the chicks.

Additional data were obtained from inoculation of embryonated eggs and transmission of infection to chicks hatched in the incubator at the same time with the inoculated embryos. A total of 188 ten-day embryos was inoculated in six different settings of eggs. Of the 91 chicks hatched from these embryos, 23 showed typical symptoms of avian encephalomyelitis. Seven of these chicks showed symptoms before they were taken from the hatching tray, and one chick showed no symptoms until it was 29 days of age. All others showed symptoms at ages between these extremes. None of the 107 chicks exposed in the incubator while hatching developed symptoms of avian encephalomyelitis infection. The effect of fumigation on brain suspensions of avian encephalomyelitis virus was investigated in three trials. Chicks inoculated with a virus suspension previously fumigated by the standard formaldehyde gas method did not develop clinical symptoms.

Consignments of chick brains were received from Georgia, New Mexico,

Ohio, and Wisconsin. Avian encephalomyelitis was definitely identified in three of the four consignments.

6. *Infectious Bronchitis Studies.* During the past year investigations were undertaken in the control of infectious bronchitis, which is a widespread, highly infectious, communicable respiratory disease of chickens causing serious losses among young chicks and laying birds.

Field investigations were started with the objective of inoculating flocks during the growing age in the hope of producing an immunity which would be of sufficient duration so that the birds would pass through at least one laying season without contracting the infection. Fourteen flocks, representing approximately 40,000 birds, were inoculated during the months of June, July, and August. The inocula were prepared from laboratory birds inoculated with a known infectious bronchitis virus. Preliminary observations reveal that birds ranging in age from four weeks to four months can be inoculated without serious objectionable post-inoculation results. However, the inoculation of birds six to ten weeks of age produced the most satisfactory results. Chicks under four weeks of age and laying birds should not be exposed to the infection.

To date no definite evidence of the disease has appeared among the birds in the inoculated flocks. Later in the season a critical test will be applied to the various flocks to determine their resistance to infectious bronchitis virus.

Laboratory investigations are in progress to develop a practical and economical method for the production and administration of the virus for flock inoculation. The development of a practical and successful inoculation program to control infectious bronchitis will mean a great economic saving to the Massachusetts poultry industry.

7. *Farm Department Brucellosis Control and Eradication.* The laboratory cooperated in this work by testing 639 bovine and 53 swine blood samples, by the standard tube agglutination method.

**Studies of Neoplastic and Neoplastic-like Diseases.** (Carl Olson, Jr.) The lymphoid tumor experimentally transmissible in chickens has been maintained in serial passage during the past year. It has retained its fundamental characteristics and in its later passages has shown no tendency to change its behavior. Apparently the tumor has assumed a fixed pattern for its action in experimental birds. The results of the first thirty serial passages have been published in an article "A transmissible lymphoid tumor of the chicken" appearing in *Cancer Research* 1: 384-392, 1941.

The collection of 384 spontaneous tumors of chickens has been investigated and much interesting information has been the result of this study. The collection was derived from three sources; namely, cases of tumor submitted to the Diagnostic Laboratory during a two-year period, cases of tumor occurring in a flock from which nearly all birds found ill or dead were examined, and cases of tumor found in birds from other miscellaneous sources. Twenty-three different types of neoplasia were found in the collection. The most common was lymphocytoma, as slightly over half (55.5 percent) of the cases were of this variety. Six other types (leiomyoma, embryonal nephroma, myelocytoma, leukosis, epithelioblastoma, and fibrosarcoma) collectively comprised about one-third (32.8 percent) of the collection. Other varieties of neoplasia found were carcinosarcoma, neurogenic sarcoma, hemangioma, fibroma, cholangioma, hepatoma, histiocytic sarcoma, myxoma, thymoma, rhabdomyoma, osteochondrosarcoma, fibrochondrosarcoma, melanoma, lymphangioma, mesothelioma, and teratoma.

Three forms of lymphocytoma were found: diffuse, nodular, and combined diffuse and nodular. A possible explanation for the existence of three forms was

developed from study of the material, and is based on the inherent resistance of the individual bird to growth of the tumor. Thus in diffuse lymphocytoma the host has but little resistance to growth of the tumor, allowing it to assume a diffuse character. In nodular lymphocytoma the host has considerable resistance to growth of the tumor, causing it to be restricted and nodular in form. The combined diffuse and nodular form develops when there is but moderate resistance of the organ or tissue in which the tumor is growing.

## WALTHAM FIELD STATION

Waltham, Massachusetts

Ray M. Koon in Charge

The members of the research staff of the Waltham Field Station are assigned to the unit by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Reports of these departments give results of investigations conducted at this station.

**Soil Testing Service.** Testing soil for commercial vegetable growers, mushroom growers, florists, nurserymen, greenkeepers, arborists, vendors of loam, and home gardeners has long been regarded as an important service which the Field Station has rendered. More recently this program has been extended to include service to the State Department of Public Works, the Metropolitan District Commission, Works Project Administration, and town and city administrations. There is no doubt that this effort is effective, particularly when the soil test is followed by a personal interview between the client and the technician. The total number of soil samples tested in 1941 was 6676.

**Field Day.** The twenty-third annual Field Day on August 6, 1941, attracted the usual number of visitors, about 1200. Perfect weather made it one of the most comfortable Field Days ever held. In an endeavor to increase the interest in the vegetable contests a few more varieties were added to the list. Valuable prizes were offered by the Boston Market Gardeners Association for the three best market packages of Bunched Carrots, Summer Pascal Celery, White Celery, Trellis Tomato, Straightneck Squash, Sweet Corn, and Cucumber. An auction of the vegetables entered in the contests proved an interesting innovation.

## PUBLICATIONS

## Bulletins

- 378 Annual Report for the Fiscal Year Ending November 30, 1940. 112 pp. February 1941.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

- 379 Trace Metals and Total Nutrients in Human and Cattle Foods. By E. B. Holland and W. S. Ritchie. 31 pp. July 1941.

This information concerning the composition of various plant materials is provided because of the very general interest in the nutritional function of certain trace elements.

- 380 Pasture Culture in Massachusetts. By William G. Colby. 44 pp. October 1941.

Pastures are of great economic importance in Massachusetts agriculture, and this study represents an attempt to organize such available information as may have a bearing on their best management.

- 381 Spraying to Control Preharvest Drop of Apples. By Lawrence Southwick and J. K. Shaw. 16 pp. February 1941.

The use of "hormone sprays" to reduce preharvest drop is a new development. This bulletin reports results of recently conducted tests in an attempt to evaluate the method, especially in relation to McIntosh

- 382 The Propagation of Some Trees and Shrubs by Cuttings. By William L. Doran. 56 pp. March 1941.

The detailed information regarding recent developments in plant propagation dealt with in this bulletin should be of significant economic importance, especially to nurserymen and foresters.

- 383 The Sanitary Evaluation of Private Water Supplies. By Ralph L. Francis. 11 pp. March 1941.

A safe water supply for rural homes is of prime importance. This is an explanation of some of the problems involved, with special attention to contamination and its detection.

- 384 The Importance of Length of Incubation Period in Rhode Island Reds. By F. A. Hays. 12 pp. July 1941.

This represents an attempt to determine whether length of incubation period may serve as a criterion of the future performance of chicks.

- 385 Natural Land Types of Massachusetts and Their Use. By A. B. Beaumont. 16 pp. May 1941.

This represents an attempt to supply certain technical information regarding soils considered essential as a basis for sound land-use studies and classifications.

- 386 Rural Youth in Massachusetts. By Gilbert Meldrum and Ruth E. Sherburne. 8 pp. December 1941.

National concern regarding the general welfare of our population deserves some planning, for which studies of this sort may furnish a basis.

- 387 Interrelationship of Land Uses in Rural Massachusetts. By David Rozman. 20 pp. December 1941.

The extent and significance of the various land uses and their relationship to each other is analyzed with a view to providing a balanced system of land utilization.



**Control Bulletins**

- 108 Twenty-First Annual Report on Eradication of Pullorum Disease in Massachusetts. By the Poultry Disease Control Laboratory. 11 pp. May 1941.
- 109 Inspection of Commercial Fertilizers and Agricultural Lime Products. By Fertilizer Control Service Staff. 55 pp. September 1941.
- 110 Inspection of Commercial Feedstuffs. By Philip H. Smith. 64 pp. October 1941.
- 111 Seed Inspection. By F. A. McLaughlin. 93 pp. November 1941.

**Meteorological Bulletins**

- 625-636, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By C. I. Gunness. 4 pp. each.

**Reports of Investigations in Journals****Numbered Contributions**

- 312 Retention of Vitamins C and A in Glass-Packed Foods. By C. R. Fellers and R. E. Buck. *Food Res.* 6 (2):135-141. 1941.
- 365 The Effect of Cocoa upon the Digestibility of Milk Proteins. By L. D. Lipman and W. S. Mueller. *Dairy Sci.* 24 (5):399-408. 1941.
- 369 Factors Affecting the Toxicity of Red Squill. By J. A. Lubitz, A. S. Levine, and C. R. Fellers. *Jour. Amer. Pharm. Assoc.* 30 (3):69-72. 1941.
- 370 Anticataractogenic Action of Certain Nitrogenous Factors. By Helen S. Mitchell, Gladys M. Cook, and Mary D. Henderson. *Arch. Ophth.* 24:990-998. 1940.
- 375 The Effect of Dry Heat upon the Anticataractogenic Quality of Certain Proteins. By Mary D. Henderson and Helen S. Mitchell. *Jour. Nutr.* 21 (2):115-124. 1941.
- 376 Transmitting Ability in Males of Genes for Egg Size. By F. A. Hays. *Poultry Sci.* 20 (3):217-220. 1941.
- 377 The Effect of the Hydrolytic Products of Casein and Deaminized Casein on the Cataractogenic Action of Galactose. By Edwin L. Moore, Mary D. Henderson, Helen S. Mitchell and Walter S. Ritchie. *Jour. Nutr.* 21 (2):125-133. 1941.
- 379 Corn Distillers' Dried Grains with Solubles in Poultry Rations. I. Chick Rations. By Kevin G. Shea and Carl R. Fellers and Raymond T. Parkhurst. *Poultry Sci.* 20 (6):527-535. 1941.
- 380 Corn Distillers' Dried Grains with Solubles in Poultry Rations. II. Laying Rations. By Fred L. Dickens and Raymond T. Parkhurst and Carl R. Fellers. *Poultry Sci.* 20 (6):536-542. 1941.
- 381 Manganese Absorption in Fowl. By Marie S. Gutowska, E. M. Parrott, and F. A. Slesinski. *Poultry Sci.* 20 (4):379-384. 1941.
- 383 Research in Food Technology in the Development of Our Fisheries Resources. By Carl R. Fellers. *Trans. Amer. Fisheries Soc.* 70 (1940):72-76. 1941.
- 384 Sex Ratio in Domestic Chickens. By F. A. Hays. *Amer. Nat.* 75:187-188. 1941.
- 386 Report on Zinc. By E. B. Holland and W. S. Ritchie. *Jour. Assoc. Off. Agr. Chem.* 24 (2):348-350. 1941.
- 387 Laboratory and Business Relationships in Foods and Nutrition. By Carl R. Fellers. *Jour. Home Econ.* 33 (2):87-93. 1941.

- 388 Effect of Processing on the Vitamin A (Carotene) Content of Foods. By C. R. Fellers. Proc. of the Food Conf. of the Inst. of Food Technol. held in Chicago, June 16-19, 1940.
- 389 Toxicity of Red Squill Powder and Extract for Chickens, Rabbits, and Guinea Pigs. By J. A. Lubitz and C. R. Fellers. Jour. Amer. Pharm. Assoc., Sci. Ed. 30 (5). 1941.
- 390 Rat Lures. By J. A. Lubitz, C. R. Fellers, and A. S. Levine. Soap and Sanit. Chem. February 1941.
- 391 A Simple Instrument for Mincing Tissue. By Carl Olson, Jr. Amer. Jour. Vet. Res. 2 (4):295-297. 1941.
- 392 Carbon Dioxide-Oxygen and Storage Relationships in Cranberries. By A. S. Levine, C. R. Fellers and C. I. Gunness. Proc. Amer. Soc. Hort. Sci. 38 (1940):239-242. 1941.
- 393 Intake of Certain Elements by Calciphilic and Calciphobic Plants Grown on Soils Differing in pH. By William H. Bender and Walter S. Eisenmenger. Soil Sci. 52 (4):297-307. 1941.
- 394 The Effect of Methods of Growing and Transplanting the Plants on the Yield of Peppers. By W. H. Lachman, Eleanor A. West, and Grant B. Snyder. Proc. Amer. Soc. Hort. Sci. 38 (1940):554-556. 1941.
- 395 Budding Ornamental Malus on the Malling Rootstocks. By J. K. Shaw. Proc. Amer. Soc. Hort. Sci. 38 (1940):661. 1941.
- 396 The Effect of Hormone Sprays on the Harvest Drop of Apples. (Abstract) By Lawrence Southwick and J. K. Shaw. Proc. Amer. Soc. Hort. Sci. 38 (1940):121-122. 1941.
- 397 The Effect of Soil Temperature on the Growth of Cultivated Blueberry Bushes. By John S. Bailey and Linus H. Jones. Proc. Amer. Soc. Hort. Sci. 38 (1940):462-464. 1941.
- 398 The Effect of Lime Applications on the Growth of Cultivated Blueberry Plants. By J. S. Bailey. Proc. Amer. Soc. Hort. Sci. 38 (1940):465-467. 1941.
- 400 Fruit Juice Concentration by Freezing and Centrifuging. By Lowell R. Tucker. Proc. Amer. Soc. Hort. Sci. 38 (1940):225-230. 1941.
- 402 A Transmissible Lymphoid Tumor of the Chicken. By Carl Olson, Jr. Cancer Res. 1 (5):384-392. 1941.
- 404 Some Factors Affecting Wheying Off of Cultured Buttermilk. By Lynn R. Glazier and H. G. Lindquist. Milk Plant Monthly 30 (5):27-30. 1941.
- 405 Corn Syrup Solids Improve Frozen Dairy Products. By Lynn R. Glazier and Merrill J. Mack. Food Indus. June 1941.
- 407 Effect of Freezing on the Available Iron Content of Foods. Preliminary Contribution. By W. H. Hastings and C. R. Fellers and G. A. Fitzgerald. Presented at Annual Meeting, Amer. Inst. Refrig., Washington, D. C., May 12-13, 1941.
- 408 A Simple Control of Damping Off. By William L. Doran. Florists' Exch. 96 (21):10. May 24, 1941.
- 409 Non-Toxic Character of Ursolic Acid. Preliminary Study. By J. A. Lubitz and C. R. Fellers. Jour. Amer. Pharm. Assoc., Sci. Ed. 30 (8). 1941.
- 410 Homogenized Milk. By J. H. Frandsen. Milk Plant Monthly, June 1941.
- 413 Propagation of Hemlock Cuttings. By William L. Doran. Amer. Nurseryman 74 (6):18-19. 1941.
- 414 Propagation of Umbrella-Pine by Cuttings. By William L. Doran. Florists' Exch. 97 (9):9. 1941.
- 415 Thianin and Pyrimidine Studies on Older Subjects. By Anne Wertz and Helen S. Mitchell, with the technical assistance of F. Catherine Higgins. Soc. for Expt. Biol. and Med. Proc. 48:259-263. 1941.

## Unnumbered Contributions

- Grass Silage for Poultry. By J. G. Archibald. New England Homestead, April 19, 1941.
- Cull Apples for Dairy Cows. By J. G. Archibald. The Rural New Yorker, June 14, 1941.
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- FM4 A Farm Management Study of Vegetable Farms in Bristol County, Massachusetts, in 1939. By Charles R. Creek. 27 pp. February 1941.
- FM5 Harvesting and Packing Iceberg Lettuce on Farms in Massachusetts. By Charles R. Creek and Richard Elliott. 12 pp. February 1941.
- FM6 Harvesting and Packing Tomatoes on Farms in Massachusetts. By Charles R. Creek and Richard Elliott. 12 pp. March 1941.
- FM7 Harvesting and Packing Celery on Farms in Massachusetts. By Charles R. Creek and Richard Elliott. 14 pp. May 1941.
- FM8 Vegetable Growing in Bristol County, Massachusetts, in 1940. By Charles R. Creek. 20 pp. October 1941.
- FM9 Two Years of Vegetable Growing in Bristol County, Massachusetts, 1939 and 1940. By Charles R. Creek. 14 pp. October 1941.
- Farm-Management Problems and Suggested Adjustments on Vegetable Farms in Bristol County, Massachusetts. By Normal R. Urquhart and Charles R. Creek. U. S. Dept. Agr., Bur. Agr. Econ. in Cooperation with Mass. Agr. Expt. Sta., Dept. Agr. Econ. and Farm Mgt. 27 pp. June 1941. (Washington, D. C.)

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- Control Calendar for Vegetable Pests. By E. F. Guba and W. D. Whitcomb. M. S. C. Ext. Leaflet 116 (revised). 24 pp. April 1941.
- Pest Control in the Home Garden. By A. I. Bourne and O. C. Boyd. M. S. C. Ext. Leaflet 171 (revised). 12 pp. March 1941.



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MASSACHUSETTS:  
AGRICULTURAL EXPERIMENT STATION,

BULLETIN NO. 398

JANUARY, 1943

## Annual Report

For the Fiscal Year Ending November 30, 1942

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The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

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MASSACHUSETTS STATE COLLEGE  
AMHERST, MASS.

[ 1943 ]  
H. H.

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# ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1942

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## DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

**Competitive Factors Influencing the Supply of Market Milk and Cream in Massachusetts.** (A. A. Brown and Abigail Stone.) Bulletin 389, the last of three bulletins based on the Springfield-Holyoke-Chicopee Milkshed, was published in 1942.

The organization of production and distribution of sales throughout the State are now being studied in relation to the program of the Massachusetts Division of Milk Control.

**Transportation Requirements of Rural Communities in Massachusetts.** (A. A. Brown and Abigail Stone.) A study of the amount of trucking necessary for the movement of grain to farmers in the Amherst-Pelham area is near completion. One cause for excessive mileage is the frequent buying in small amounts by many farmers. Much time and probably much mileage could be saved if farmers would place their grain orders monthly and take at one delivery quantities up to the permissible mileage of the handler's truck. This sort of arrangement would reduce stops by 50 percent and result in an average delivery of .48 tons per mile. Comparison with mileage under actual conditions was not possible because some operators kept neither trip nor mileage records. Study of farmers' buying practices indicates that worthwhile reduction in mileage could be accomplished by fully utilizing handler's equipment.

### **Crop and Livestock Enterprise Relationships.** (C. R. Creek.)

*Results of Pasture Improvement Practices.* Detailed grazing records were kept for the 1941 season, in connection with a record of milk production, barn feeding, and pasture treatment. Acreage of pasture ranged from 10 to 113 acres per farm with an average of 34 acres. More intensive improvement practices were applied to the small areas. Size of dairy herds ranged from 8 to 45 cows per farm with an average of 24 head. The length of pasture season was variable, chiefly because of drought in late summer, and ranged from 65 to 164 days with an average of 121.

Results from the grazing of these pastures were calculated in pounds of 4 percent milk, number of cow-days, and tons of green forage. For the relatively short season of 1941 an average of 2017 pounds of 4 percent milk was produced from each acre of improved pasture. The range per farm was from 313 to 6648 pounds per acre. Cow-days of grazing ranged from 22 to 152 on these farms with an average of 74 per acre. Production of green forage was calculated as an average of 2 tons per acre with a range from 0.5 to 3.0 tons per acre per farm. Returns for individual fields on these farms varied more widely than the range given for averages by farms.

Improved pastures consisted of annual crops, Ladino Clover, mixed clover and grass, and permanent grassland. Returns were highest for Ladino Clover pastures with 3,044 pounds of milk, 84 cow-days, and 2.7 tons of forage per acre. Clover and grass pastures ranked second, followed by annual pasture crops and permanent pastures. Returns were also calculated by types of treatment, but the variation was slight.



**Labor-Saving Methods and Practices on Massachusetts Farms.** (C. R. Creek.)

An outline has been prepared to apply the results of previous research on labor-saving practices to the production and harvesting of vegetable crops on small farms. Inexpensive and homemade adaptations of labor-saving equipment are recommended for these farms.

**Comparative Costs of Producing Corn and Grass Silage.** (C. R. Creek.) Preliminary tabulations and calculations have been made of various items in the cost of producing corn and legume-grass silage on dairy farms in the Connecticut Valley counties. Cash costs of growing and harvesting corn for silage ranged from less than \$1 per ton on a farm with no hired labor and no fertilizer expense to \$5.06 per ton on a farm where machinery was hired for all growing and harvesting work and all labor was hired. Total costs were much higher and ranged from \$4.93 to \$9.13 per ton. Total costs included such non-cash items as family labor, depreciation, interest, and the value of manure. The acreage of corn for silage ranged from 3 to 21 acres per farm with a total production of 20 to 200 tons. Yields ranged from 5 to 16.5 tons per acre.

Cash cost of legume-grass silage ranged from \$2.37 to \$3.60 per ton and total costs from \$5.30 to \$9.45 per ton. Acreage of the various crops ranged from 2.5 to 40 acres per farm and yields of grass silage were from 3.8 to 8 tons per acre. Small acreages of oats used as a nurse crop for clover seedlings were ensiled on a few farms. Cash costs ranged from \$2.55 to \$4.53 per ton and total costs from \$5.90 to \$10.69. Yields varied between 6 and 10.5 tons per acre of oats for silage.

**Loan Performance on Low-Income Farms in Massachusetts.** (C. R. Creek.)

Data and information have been obtained from the farm plans for Farm Security Administration borrowers in Franklin, Hampden, and Hampshire counties. Tabulations have been made by counties for cash-crop and for livestock farms. Preliminary observations indicate that the rate of repayment of loans has been much higher on the cash-crop (onions, tobacco, and potatoes) farms than on the dairy and poultry farms. A small number of the latter have been liquidated at public auction to repay the Farm Security Administration loans.

The chief reason for loans to cash-crop farmers in the Connecticut River Valley was the loss of crops in the flood and hurricane of 1938. Low prices for crops and low yields in earlier years were responsible for the deplorable credit situation of many small operators. Increasing the size of business from a part-time or subsistence level was the reason for many livestock loans, particularly on poultry farms. Some of these operators have now returned to a part-time farm business and are working in industrial plants in nearby cities.

**DEPARTMENT OF AGRONOMY**

Walter S. Eisenmenger in Charge

**Tobacco Projects.** (Walter S. Eisenmenger and Karol J. Kucinski.)

*Brown Root-Rot of Tobacco.* In the experiment to determine the effect of preceding crops on tobacco it was found that tobacco, artichoke, and sunflower, as well as fallow, were beneficial as contrasted with such crops as corn, sudan grass, and sorghum, which in all cases seemed to have a deleterious effect on yield.

The crops preceding tobacco were planted at three different times: the first, early; the second, thirty days later; and the third, thirty days later than the second. The earliest planting was completely mature; the others matured to a lesser degree. The earliest planting developed more lignin than the others. These plants were permitted to stand and become thoroughly dehydrated by subsequent freezing and thawing.

Where the individual plants were of the type that prevents the growth of weeds—shade producing plants—the yield of tobacco increased after the late plantings. In plots of small plants, such as barley, rape, and rye, the weeds in late summer intrude and to a degree vitiate the results.

There is no evidence, however, of a better quality of tobacco grown after immature plants. This is not entirely new, for it is often the case that larger tobacco plants do not cure as well as smaller tobacco plants.

*Tobacco Experiments with Application to Soil of Commercial Organic Materials.* Different types of carbon compounds were applied to the soil to study their effect on the yield of tobacco. Because of prohibitive cost, there are not many such compounds that can be used; but cane sugar, starch, dried skim milk, and charcoal were each applied to duplicate plots at the rate of 100 pounds per acre. No decided differences were noted in the tobacco although the check plots receiving no additions of carbon were low in yield and crop index. The charcoal caused more rapid growth in the early season, probably because of the more abundant absorption of heat by the darker color induced, and also gave the highest yield, suggesting the possibility of its use in early spring for frames where seedlings are grown. The dried milk left a residual effect the following year for the cover crop of rye. Increased growth on these two plots was pronounced, suggesting two possible factors—the nitrogen in the milk, or the subsequent action of lactic acid which may have influenced the soil flora.

**The Absorption by Food Plants of Chemical Elements Important in Human Nutrition.** (Walter S. Eisenmenger and Karol J. Kucinski.) Calcium, magnesium, sodium, and potassium salts, at the rate of 200 parts per million of each cation, were added singly to soil growing vegetables. The increase of these cations in plant tissue, when cations were added singly to the soil was as follows: for cabbage—calcium 30 percent, potassium 127 percent, magnesium 543 percent, and sodium, none; for celery—calcium 44 percent, potassium 256 percent, magnesium 390 percent, and sodium 52 percent; for lettuce—calcium 12 percent, potassium 132 percent, magnesium 346 percent, and sodium 72 percent; for carrots—calcium 18 percent, potassium 24 percent, magnesium 42 percent, and sodium 106 percent; and for beet roots—calcium 22 percent, potassium 12 percent, magnesium 85 percent, and sodium 356 percent.

Larger amounts of magnesium, potassium, and sodium can be introduced into plants than of calcium. Also, more of the halides can be introduced into plants than of phosphorus or sulfur.

It may be said that those elements which are abundant in sea water may be introduced into plants more readily than the elements which are abundant in land waters.

**The Intake by Plants of Elements Applied to the Soil in Pairs Compared to the Intake of the Same Elements Applied Singly.** (Walter S. Eisenmenger and Karol J. Kucinski.) Cabbage, celery, lettuce, and string beans were grown after application to the soil of 250 parts per million each of calcium, sodium, and potassium, singly and also in all possible combinations. Results show that when these ions were applied in pairs, the amounts taken in by the plant were lower than when they were applied singly. This behavior is suggestive of the well-known premise that up to a certain point one of these elements can serve the function or purpose of the other.

**Magnesium Requirements of Plants.** (Walter S. Eisenmenger and Karol J. Kucinski.) Nearly one hundred species of plants have been grown on a magnesium deficient plot, one-fourth of which receives magnesium sulfate; one fourth-

magnesium sulfate and lime; one-fourth, lime alone; and the other fourth, neither lime nor magnesium.

The demonstrations have developed to a significant degree—to show what plants need this element. However, the obvious chlorosis seems not to be the whole story; for we have found plants regarded as weeds which do not grow at all where no magnesium is added, and one cultivated plant which does not chlorose but does much better if magnesium is added, and there are plants which have symptoms of potassium deficiency where no magnesium is added, as in the case of the apple tree.

**Soil Conservation Research Projects.** (Karol J. Kucinski and Walter S. Eisenmenger.)

*A Study of the Physical and Chemical Properties of Wind-Blown Soils.* Wind erosion in the Connecticut Valley occurs mostly on onion and vegetable fields when previously frozen soils thaw, then dry, and are swept off by drying, north-westerly winds. In general, these wind-blown soils are coarser than the soils least affected. It is important from both the practical and academic viewpoints to find out just what physical-chemical properties determine the degree of erodibility of a soil, which of these properties are controllable, and what takes place in the soil complex when one or more of these properties are changed.

During the past year, in cooperation with the Soil Conservation Service, the problem of wind erosion has been studied. Soils from wind-eroded and uneroded areas are being examined by the use of a wind tunnel 32 feet long by 3 feet by 3 feet, especially designed for local conditions. Wind velocities as high as 50 miles an hour can be generated and instruments are used to record the wind velocities and amounts of erosion. Preliminary trials with the tunnel have given interesting results, and it is expected that the information finally obtained will help greatly in understanding why certain soils erode more than others and possibly in establishing means for their stabilization.

*A Survey of Erosion Problems Arising from Changes in Land Use.* The growing of potatoes on a large scale is a relatively new venture on some of the farms in Massachusetts, especially in the western foothills and plateau. Many acres of old sod have been plowed under on the sloping hillsides—in some cases, fields which have not been in open cultivation for the past thirty years. The potato yields from such fields have been very encouraging and in most cases, therefore, the operators have not been interested in soil conservation practices. As yet, only slight sheet erosion is noticed, probably because of the presence of large amounts of organic matter. Great concern has been felt by some who think that after a few years of open cultivation, the organic matter originally present in these new potato fields will decompose and the soil will readily erode, since cover cropping has not been practiced.

Determinations of carbon and loss on ignition indicate that a large decrease in the organic matter content of some of these soils has already taken place. There was an average decrease of 9.5 percent of soil carbon in 1940 compared with 1939 and a 21 percent decrease in 1942 compared with 1939. The "loss on ignition" of this same soil, which is a measure of organic matter, showed an average decrease of over 10 percent. It is deemed advisable, therefore, to encourage potato growers to practice soil conservation methods such as winter cover cropping and terrace and contour farming of their hillsides.

**Sunflowers and their Possibilities.** (Karol J. Kucinski and Walter S. Eisenmenger.) For the past four or five years, sunflowers have been grown in the hope of finding out whether the crop is adapted to our soil and climate. Results show that sunflowers can be grown here and produce seed abundantly. However, to



the best of our knowledge, no one in Massachusetts is growing sunflowers in commercial lots, probably because of the lack of proper mills for processing the oil. The cost of transportation to mills in the Midwest would not justify shipment even in normal times. Some seed is grown locally and used as a conditioner of poultry.

Sunflowers will grow in Massachusetts on any land which will produce field corn and a corn fertilizer seems to do very well. There is an element of risk involved in the growing of the crop which should not be overlooked. The plant is very susceptible to damage from windstorms and there was complete crop failure after the 1938 hurricane. The "wind-fall" of the sunflower plant is due to a large extent to infestation with the corn borer. Planting the seed too close will produce small and thin sunflower plants, too weak to withstand strong windstorms. One seed per hill every 18 inches in 36-inch rows gave an average crop of over 2 tons of clean seed per acre. The wholesale price of sunflower seed quoted on the western coast ranges from seven to eight cents a pound.

Sunflowers are hardy to light frost, and can be planted at the time it is safe to plant field corn. Harvesting is usually done during the latter part of September. A growing period of 120 to 140 days, depending on the season, is sufficient for maturing the seed in Massachusetts. It has been found best to cut the sunflower heads off the stalk and place them singly on boards to dry for two or three weeks. This drying facilitates the removal of the seed from the head by striking the head against some object or rubbing it on a very coarse wire screen.

**Black Root-Rot of Tobacco.** (C. V. Kightlinger.) The project to improve tobacco production in Massachusetts by producing strains of Havana Seed which are satisfactorily resistant to black root-rot and also acceptable in type, quality, yielding capacity, and habits of growth in general, is being continued. Strains of tobacco which possess most of these properties have been produced, but they have not been entirely acceptable to some leaders of the tobacco trade. Attempts to improve the strains by selection have succeeded in making changes but only in minor properties. New strains produced by breeding show promise of producing the desired results.

Results obtained from small plot tests show two of the new strains to yield well not only in soil free from black root-rot, but under bad black root-rot promoting conditions, as well. They have good general type and produce leaves which have good shape, smaller veins than many strains, and good body and quality. These strains mature as early as the common Havana Seed which was used as one of the parents and bear a close resemblance to that parent in most respects. They have not yet been tested in commercial production.

**Brown Root-Rot of Tobacco** (C. V. Kightlinger.) The project to determine the effects that high and low fertility of the soil may have on the occurrence of brown root-rot of tobacco is in progress, but work has not yet gone beyond the treatment of soil necessary to produce those differences in fertility.

**Soil Treatments for Tobacco Seedbeds.** (C. V. Kightlinger.) Experiments were made again during the fall of 1941 and the spring of 1942, to test the effectiveness of several different soil treatments in controlling damping-off diseases, but results were disappointing because even the control plots showed no evidence of the disease.

In the control of weeds, there were wide differences between the different treatments; also, between replications of the same treatment, except in the case of steaming and the combination treatments with chloro-picrin and calcium cyanamid. Steaming was done by the pan method at a steam pressure of about 100 pounds applied for 20 minutes, with the pan kept in place for another 20 minutes.



This gave good control of weeds in all replications, whether done in the fall or in the spring. The combination treatment of chloro-picrin and calcium cyanamid consisted of 2 cc. of chloro-picrin per square foot and one-half pound of calcium cyanamid per square yard of soil surface, applied only in the fall. This treatment was not so effective as steaming, but it gave fair control of weeds in most of the replications.

**Onion Breeding.** (Hrant M. Yegian.) Tests were made during the season of 1942 on the Hubbard farm in Sunderland, Massachusetts, to compare the yields of onions obtained from sets planted by machine with yields of onions obtained from sets planted by hand, and to determine the effect that spacing of sets within the row might have on both the yield and size of bulbs produced.

The sets planted by hand yielded an average of 51 pounds of Number 1 onions per 50-foot row, compared with 33.5 pounds for machine-planted sets with supplementary hand work for checking and respacing. With the machine, the spacing and the yield are not uniform. The number of plants in a 50-foot row varied from 153 to 218, compared with 238 to 264 plants per row in the hand-planted sets. The yield obtained from machine-planted sets varied from 29 to 44 pounds compared with 49 to 54.5 pounds from hand-planted sets. Another important factor affecting the yield and the stand of machine-planted sets is the fact that sets are not always placed in an upright position. There was a loss of 25 percent in yield when sets were placed horizontally in the row by hand, and 80 percent when planted bottoms up in the experimental plot at the College. These figures will, of course, vary from year to year depending on weather conditions prevailing soon after the sets are planted. The weather during April and the early part of May this season was very dry and warm, which may account for the poor start made by sets planted horizontally or bottoms up. Although the machine-planted sets did not yield as well as the hand-planted sets, it would seem that the use of this machine should be encouraged in the Valley because of the saving in labor. Even spacing could be secured by carefully sizing the sets into several grades.

Spacing of sets in the row had a marked influence on the yield and to some extent on the size of the bulbs. When sets were spaced 2.1 inches, 3.2 inches and 4.2 inches apart in the rows, the average yields of Number 1 onions were 51 pounds, 40.5 pounds, and 32.5 pounds per 50-foot row, respectively; and the average weight of bulbs was 0.2 pounds, 0.22 pounds, and 0.23 pounds, respectively.

The data covering one year of field experiments on the effect of storage temperatures on the keeping quality of bulbs and on the subsequent seed-stalk development of mother bulbs at uniform weight (40-45 grams) warrant the following general statement:

1. Bulbs stored at 32°F. kept best. Bulbs stored at 45° had 15 percent of sprouting, while those stored at 60° - 70° had 18 percent of sprouting and 5 percent of soft rot.

2. Bulbs stored at 45°F. were the first to send out seed stalks, followed by those stored at 60° - 70°. The bulbs stored at 32° were 7 - 10 days later than those stored at 45°.

3. The storage temperature had a marked effect on the number of seed stalks produced. When bulbs were stored at 60° - 70°F., 33 percent of the bulbs had 2 seed stalks per bulb; 30 percent, 3 seed stalks; and 25 percent, 4 seed stalks; when stored at 45°, 53 percent of bulbs had 2 seed stalks per bulb; 32 percent, 3 seed stalks; and 8 percent, 4 seed stalks; and when stored at 32°, 76 percent of the bulbs had 2 seed stalks per bulb; 17 percent, 3 seed stalks; and 4 percent, 4 seed stalks.

Although the amount of seed produced by the several lots of bulbs differed, it is not certain that the storage temperatures were entirely responsible for these differences. Further investigation of this phase of the problem is needed.

There was no significant difference in time of maturity between commercially grown onions in the Valley and onions grown from sets selected for early and late maturity. On account of weather conditions this year, commercially grown onions matured from 2 to 3 weeks earlier than usual, which may explain the failure to obtain any advantage from using specially selected sets.

Sets were produced this year from second generation selfed lines for the study of inheritance of number of seed stalks per plant; from crosses for double and single bulb characters; and from crosses between white Persian and Ebenezer variety.  $F_2$  seed was secured from the white Persian  $\times$  Ebenezer cross.

Sterile-species crosses between *Allium fistulosum* and *A. cepa* L. were treated with calchicine to induce polyploidy. Calchicine in a 2 percent aqueous solution was lethal to all the early stages of inflorescence when immersed for one hour, and few of the flowers that were about ready to open on well-developed inflorescence survived the treatment. Their stigmas were stunted and swollen and no pollen ripened. One of the hybrids which was not treated with calchicine matured 5 seeds. These seeds were planted as soon as mature, in the greenhouse. Although all of the seeds germinated, only two seedlings survived. Cytological examination of the meristematic tissues will be made to determine the chromosome number of these plants.

The hybrids of the *A. fistulosum*  $\times$  *A. cepa* cross show the characteristics of multiplier onion. One of the year-old bulbs separated into 16 parts, each bulblet having a flower-stalk.

**Hybrid Field Corn.** (Hrant M. Yegian.) Further trials with early-maturing hybrid field corn for the higher plateau regions of Worcester County and the western counties of Massachusetts were conducted at the College Farm. A few of the promising hybrids will be tested next season in the northern part of the State.

Nine early-maturing hybrids—Maine A, Wis. 240, Wis. 255, Minn. 402, Minn. 700, Minn. 800, Cornell 34-53, Ohio M15, and Quebec flint—from last year's trial plots at the College were tested this year for maturity and yield in the northern part of the State where the growing season is shorter and cooler than it is here. Maine A was the only one that matured under those conditions.

In order to become familiar with the performance of recently developed out-of-state hybrids offered for sale in Massachusetts for late grain and silage purposes, yield tests with 27 hybrids were conducted at the College Farm. The year 1942 was very favorable for corn production. The long ripening season permitted relatively large, late-maturing hybrids to ripen satisfactorily; but in a year with a shorter ripening season, the results may be very disappointing.

**Available Phosphorus.** (A. B. Beaumont.) The distribution of "available" phosphorus in the soil profile as affected by soil type and management is being studied. Determinations of soluble phosphorus made to date indicate that past treatment is a more important factor in determining the amount of phosphorus extracted by this method than is soil type. Long use of phosphatic fertilizers has caused an accumulation of acid-soluble phosphorus in the topsoil, the amount varying with the degree of fertilization. Topsoils which have been heavily fertilized for years, as in truck growing and tobacco culture, have been found to be relatively heavily charged with phosphorus considered available by the method of extraction used. Corresponding subsoils have been found to contain little available phosphorus.

**Potato Variety Trials.** (Ralph Donaldson, Walter S. Eisenmenger, and Karol J. Kucinski.) Based on yields of marketable size, the ranking of potato varieties grown in plots at the college during the season of 1942 were Sequoia, Pontiac, Green Mountain, Houma, Red Warba, Russet Rural, Chippewa, Earlane, S-46592, Katahdin, Sebago, S-46000, and Irish Cobbler.

**Ryegrass as a Green Manure Crop.** (Hrant M. Yegian.) The use of domestic ryegrass (*Lolium* sp.) as a winter cover crop and green manure is becoming more or less a general practice on the better-managed vegetable farms. It is one of the best all-round winter cover crops in this region, where the temperature during the growing season in the fall is moderately cool. Ryegrass is easily grown, and on fertile soil makes a complete cover quickly. Its heavy mat of roots retards severe soil erosion from wind or rapid run-off of rain. It may be seeded, in most cases, as soon as the previous crop is removed. With set onions, ryegrass may be seeded at the rate of 20-25 pounds per acre, in the early part of August, after the onions have been harvested and moved out of the field, although seeding even as late as the early part of September has given a satisfactory cover crop at this station. The yield (0.5-1.5 tons of dry tops) will vary, depending upon the time of seeding and the amount of available moisture and plant nutrients during the growing period. It is moderately winter-hardy. From 50 to 60 percent of the plants will survive the average winter; so unless the ryegrass is completely turned under in the spring during the plowing operation, volunteer plants may interfere with the cultivation of the subsequent crop. Experience here has shown that a very satisfactory seedbed for the set onion crop can be prepared by plowing under the cover crop in early spring.

**Influence of Soil Fertility on Productiveness of Pasture Species.** (Hrant M. Yegian.) In 1941 a field plot experiment was started with thirteen species of grass to determine their relative productivity and ability to winter over and to recover from cutting. These grass plots were maintained in pure stand at different levels of soil fertility which were secured by the addition of lime (1000 pounds per acre) and 5-8-7 fertilizer in increments of 400 pounds per acre. Data covering the second year of the experiment warrant the following statement:

All the species continued to respond as well in their second year as in their first, to increases in soil fertility levels.

The soil fertility requirements of different species vary. There was a pronounced or consistent increase in yield with additional applications of commercial fertilizer, but the percentage increase in yield was not the same for all the species at each level of soil fertility. Reed canary grass, colonial bent, orchard grass, and Kentucky bluegrass produced proportionally more dry tops at the higher soil fertility levels (800 to 1600 pounds of 5-8-7 fertilizer per acre); while timothy, fowl bluegrass, red top, and meadow fescue produced proportionally more dry tops at the lower levels (400 to 800 pounds of 5-8-7 fertilizer per acre); and there were a few species, including meadow foxtail and smooth brome grass, that produced in direct proportion to the amount of fertilizer added.

The perennial ryegrass was completely winterkilled in its second year. Kentucky bluegrass, reed canary grass, timothy, and smooth brome grass gave a greater yield in their second year than in the first in the fertilizer plots; meadow fescue, colonial bent, orchard grass, rough-stalked meadow grass, and meadow foxtail produced less in their second year; while red top and fowl bluegrass maintained their yield at the same level both years.

**Experiments at Amherst with Hay and Pasture Seeding Mixtures.** (W. G. Colby.) Additional data were obtained from three series of plots planted with different hay and pasture seeding mixtures in 1940 and 1941. Details of the



plan of the experiment were given in last year's report (Mass. Agr. Expt. Sta. Bul. 388:14-15, 1942).

Yields of both hay and pasture herbage on plots seeded in 1940 were lower this year than last year. Plots which produced at the rate of  $3\frac{1}{2}$  to 4 tons of dry matter per acre last year produced 3 to  $3\frac{1}{2}$  tons this year. Reduced yields resulted, notwithstanding the fact that growing conditions so far as the weather was concerned were much more favorable this past season than they were a year ago. Total rainfall for the period from March 1 to November 1, 1942, amounted to 30.55 inches, slightly above normal for this period, whereas the total rainfall for the same period in 1941 was only 22.02 inches.

These experimental results are consistent with what has been observed in newly seeded hay and pasture lands in Massachusetts for many years. Unless weather conditions or other circumstances are extremely unfavorable, yields will be highest the year following seeding. This is true for both spring and summer seedings. Yields can be expected to fall for two to three years following the second year of maximum production until a fairly constant production level is reached, which will approximate one half to two thirds of the maximum figure. Careful grazing management in pastures and regular topdressing applications of suitable fertilizers will slow up the rate of decrease, but they will not prevent it. Managed grazing of the plots in this experiment, together with a topdressing application of 200 pounds of 40 percent superphosphate and 325 pounds of muriate of potash per acre in the fall of 1941, did not prevent yield levels from falling in 1942.

Of the three grasses—smooth brome grass, late-maturing types of orchard grass, and meadow fescue—which produced well in association with Ladino clover in 1941, only meadow fescue failed to compete satisfactorily in 1942. The total production of these grasses in association with Ladino clover was not only high but was fairly uniformly spread over the season. Smooth brome grass and Ladino clover for example, yielded 1015 pounds of dry herbage in May, 1600 pounds in June, 1065 pounds in July, 920 pounds in August, and 770 pounds in October. These yields may be compared with those from the timothy, alsike, red clover plots which were 1210, 1160, 770, 770, and 340 pounds for the same harvesting dates.

Promising results were again obtained from the series in which a crop of hay was cut followed by grazing. A mixture of smooth brome grass, Ladino clover, and alfalfa produced 4040 pounds of hay in mid-June, 1065 pounds of grazing in July, 1015 pounds in August, and 870 pounds in October. The timothy, alsike, red clover mixture yielded 5180 pounds of hay in late June, no grazing in July, 970 pounds in August, and 680 pounds in October.

Some of the leafy, late-maturing strains of orchard grass performed moderately well with Ladino clover and also when alfalfa was added, but the commercial strains of orchard grass were not satisfactory. In the pasture plots they were all too vigorous in their growth habits and tended to crowd out the legumes even though grazing was carefully controlled and the plots were clipped after each grazing period. In the hay plots these strains matured too early for the alfalfa.

Although the common variety of orchard grass has been frequently recommended to farmers, this grass has never found widespread favor. It has recently been recommended as a companion grass for Ladino clover. The past two years' results indicate that the reluctance on the part of farmers to grow it extensively is well founded. Except where soils are fertile and well supplied with moisture and also where grazing is carefully controlled and the means are available for clipping following grazing, disappointing results with Ladino clover and orchard grass are likely. Even under such circumstances no more than three to five pounds of the grass seed should be sown to the acre.



In an effort to eliminate some of the bad features of orchard grass, breeders have developed a number of new and improved strains. Several of these were included in the test and it is from some of these strains that promising results have been obtained. The outstanding one thus far is S37, a strain developed by the Welsh Plant Breeding Station in Aberystwyth, Wales. Three strains from this source were tested — S26, S37, and S143 — but S37 gave the best all-round performance. It is leafy, late-maturing, moderately vigorous and upright in its growth habit, and a reasonably good seed producer. It looked well in combination with both Ladino clover and alfalfa and appeared to be adapted for use as pasture or hay and pasture combined. A satisfactory proportion of legumes to grasses has been maintained for two years in plots seeded with five pounds of S37 orchard grass, two pounds of Ladino clover, and ten pounds of alfalfa.

Svalof's early meadow fescue, a short, narrow-leaved type, grew well the first season with Ladino clover, but was unable to maintain a stand throughout the second season. Commercial strains were eliminated the first season. The Svalof strain has been of interest, because it is apparently immune to leaf rust, a factor which may explain why it is more persistent than commercial strains. Although meadow fescue is apparently unsatisfactory when grown alone with Ladino clover, there are indications that five to eight pounds might be seeded along with four to five pounds of a leafy strain of orchard grass or eight to ten pounds of smooth brome grass, with excellent results. Meadow fescue is a fast-growing grass which establishes itself quickly and would retard weed growth and yield considerable feed while the slow-growing brome grass or orchard grass was becoming established.

Strains of the so-called tall meadow fescue, such as Alta tall fescue, have not performed satisfactorily. They are coarse and unpalatable in comparison with several of the other grasses and offer too much competition for Ladino clover.

## DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

**A Study of the Mineral Elements of Cow's Milk.** (J. G. Archibald, C. H. Parsons, and H. G. Lindquist.) For two reasons the work with manganese reported last year was repeated during the winter of 1941-42: (1) the findings were at variance with some earlier work at another station, so it was thought advisable to confirm them; (2) it was desired to investigate the possible effect of metabolized manganese on the development of oxidized flavor in milk.

The results of this second season's work confirmed the finding reported last year that the amount of manganese in milk can be doubled by adding manganese to the ration fed. This additional metabolized manganese did not retard or inhibit the development of oxidized flavor either in ordinary milk or in milk to which copper had been purposely added to accentuate the effect.

The element zinc is being studied this year.

**Investigation of the Merits of Legume and Grass Silage for Massachusetts Agriculture.** (J. G. Archibald and C. H. Parsons.) War economy has resulted in a definite shortage and a corresponding increase in price of the two most common preservatives for grass silage, molasses and phosphoric acid. Our efforts this year have, therefore, been devoted to a study of other materials which might possibly be used as preservatives, and to an improvement of methods in general so that smaller amounts of preservative or none at all, may suffice.

It was not possible to conduct any feeding trials with the molasses silage stored in the large experimental silo in June 1941. The excellent quality of this silage

was, however, very evident; the odor was mild and sweet, and the cows ate it much more readily than they did a similar lot preserved with phosphoric acid in the same silo the previous year.

A second silo containing 75 tons of mixed grass was inoculated at five different levels at filling time in June 1941, with a pure culture of *Bacillus bulgaricus*. No other preservative was used. This silo was opened in January 1942; there was considerable spoilage at the top and sides and the odor at first was very objectionable, indicating formation of excessive amounts of butyric acid. The odor improved after the top layers were fed off, but continued more sharply acid than the odor of the molasses silage referred to above, although the pH was 4.4 in contrast to 3.9 for the molasses silage. The station bacteriologist was unable to recover *B. bulgaricus* from the silage, which suggests that the inoculation may have played little if any part in the fermentation.

The silage was fed to young cattle; they ate it readily but made somewhat smaller gains than when fed corn silage. This may have been due, however, to inherent feeding value of the original material rather than to method of preservation. It would have been desirable to include another silo of similar material not inoculated, as a control. This has been done this year, but at this date (Nov. 30) the silos have not been opened.

In addition to the three large silos filled this year, using respectively molasses, bacterial inoculation, and no preservative (control), sixteen miniature silos have been filled, each containing approximately one and a half bushels of chopped grass or alfalfa, and weighted with concrete blocks to produce a pressure of about 120 pounds to the square foot. Two crops, mixed grass and alfalfa, at two different moisture levels, have been ensiled in these miniature silos with the following treatments: (1) no preservative, (2) inoculation with *B. bulgaricus*, (3) salt, (4) *B. bulgaricus* plus salt. At date of writing (Nov. 30) six of these small silos have been opened and their contents studied from a biochemical, and to a lesser extent from a bacteriological standpoint. The outstanding facts thus far are: (1) the excessive amount of butyric acid which has developed regardless of the preservative used, and (2) the complete absence of lactic acid from these silages.

**A Study of Urea as a Partial Substitute for Protein in the Rations of Dairy Cows.** (J. G. Archibald.) This project has recently been discontinued for the duration of the war. Final conclusions are not being drawn at this time, but results of feeding trials extending over three years indicate that while the urea has been utilized by the cows to some extent it has not proved equal to the standard protein concentrates as a source of nitrogen for milking cows.

**The Effect of Feeding Irradiated Dry Yeast on Reproduction and General Health in Dairy Cows.** (J. G. Archibald and J. D. Neville.) Two years' results with sixty cows in the Gardner State Hospital herd show no differences of any significance between the cows getting irradiated yeast and those on the control ration. This lack of response may be due to the fact that this herd has always been maintained at a rather high nutritional level. The level of vitamin D fed was approximately 10,000 international units daily per cow.

Determination of the phosphatase level in the blood of twenty of these cows (ten in each group) at regular intervals during January, February, and March of this year showed no significant differences between the groups in this constituent. Since a rise in blood phosphatase is considered to be a sensitive indicator of vitamin D deficiency, it seems evident from these results that the cows in this herd were not suffering from even a slight deficiency of this vitamin; therefore, the lack of response to the feeding of irradiated yeast is quite understandable. The project in its present form and as involving the use of the Gardner herd has been terminated.

## DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

**Nitrification in Soils Containing Plant Residues of Varying Lignin Content.** (James E. Fuller, cooperating with the Agronomy Department.) This investigation, so far as the field work is concerned, is obviously seasonal and consequently proceeds slowly. A preliminary statement was made in the 1941 report from this Department (Mass. Agr. Expt. Sta. Bul. 388: 19, 1942). The crops employed were millet, rye, wheat, sudan grass, sorghum, corn, oats, buckwheat, barley, rape, artichoke, tobacco, and sunflower. There were six plots with all of the crops in each, except the sunflower, which was alternated with fallow strips. The crops were grown and then plowed under. The following season tobacco was grown on the plots, and during that season three series of soil samples were collected — one early in the season before the tobacco was planted, another in mid-summer, and the third in the early autumn after the tobacco had been harvested. These samples were tested for their ability to nitrify dried blood and ammonium sulfate.

The general tendency seemed to be that the capacity of the soil to nitrify dried blood declined in mid-summer as compared to the spring, and then recovered to some extent later in the season. There was considerable variation among the different plots, and no definite relationship could be noted between the variety of crop and the nitrifying capacity of the soil of the plot. The ability of the soils to nitrify ammonium sulfate declined markedly, in general, when the early and mid-season samples were compared, and there was little recovery of activity when the late-season samples were analyzed.

The nitrification results are being compared with the production and the grade and crop indices of tobacco grown on the plots. No relationship has been noted, but further study of the data is being made.

**The Determination of the Sanitary Quality of Drinking Utensils.** (Ralph L. France and James E. Fuller.) This project had been carried on by France, and after he entered the armed service of the country the work was taken over by Fuller, who completed some unfinished work and prepared a report. The results may be summarized as follows: A wet swab with excess moisture squeezed out was more effective than a dry or a moist swab for removing bacteria from used drinking glasses. A diluting fluid containing a phosphate (Butterfield's phosphate) was more effective than distilled water or physiological salt solution for preserving the viability of bacteria on swabs when they had to be held for some time before plates were made. When swabs had to be held for several hours before plates were made, it was found that chilling the containers with ice helped materially in preventing loss of viability of the bacteria. A yeast-dextrose medium similar to that used for the Standard-Methods procedure for plating milk samples gave good recovery of bacteria for swabs. Practical examinations were made of local establishments serving food and drink.

**Bacteriological Study of Chocolate Milk.** (James E. Fuller and R. W. Swanson, in cooperation with W. S. Mueller of the Department of Dairy Industry.) This study has been completed and the results published. They may be summarized as follows: The addition of chocolate syrups or cocoa powders inhibited the growth of bacteria as compared with growth in the milk without the powders or syrups. Even though the bacterial content of some of the powders and syrups was high, the resultant growth of bacteria in chocolate milk made from these powders or syrups was not nearly as great as was anticipated. Experiments indicated that the tannic substances in the chocolate or cocoa were responsible for the inhibition of bacterial growth.



**Bacteriological Studies of Rural Water Supplies.** (James E. Fuller.) This project has been started within the year. Some preliminary work along this line has already been reported (James E. Fuller and Sonnia Levine, Mass. Agr. Exp. Sta. Bul. 378, 1941). Present experiments are being done on an amplified scale. The study aims to attempt a differentiation of the intermediate members of the coliform group of bacteria, so frequently encountered in rural water supplies (wells or springs), to learn how many of them indicate serious pollution and how many indicate merely surface wash. The differential reactions (Imvic tests) of these bacteria are being studied at several incubation temperatures, from room temperature to 46°C. (Eijkmann-test temperature), to determine the proportion that are related to the fecal *Escherichia coli*. Present indications are that the use of the Eijkmann-test temperature for incubating the Imvic tests may be useful in evaluating the sanitary quality of rural water supplies.

**Laboratory Service.** (R. L. France, until July 1942; James E. Fuller, beginning July).

Milk (bacteria counts).....	392
Ice cream (bacteria counts).....	91
Milk (butter fat).....	27
Water.....	107
Miscellaneous.....	3

## DEPARTMENT OF BOTANY

### A. Vincent Osmun in Charge

**Diseases of Trees in Massachusetts.** (M. A. McKenzie and A. Vincent Osmun.)

*The Dutch Elm Disease Problem.* The Dutch elm disease caused by the fungus, *Ceratostomella ulmi* (Schwarz) Buisman, and spread by bark beetles was found in Massachusetts in 1941. During 1942, investigation of this disease in the State has had three main objectives: the discovery and eradication of diseased trees; the evaluation of the importance of woodpiles as sources of the causal fungus and carrier beetles; and the elimination of conditions favorable to the spread of the disease.

Results of the inoculation of several species of elm with the causal fungus in early summer under controlled conditions in the greenhouse indicate that all species of elm are susceptible; but American elm (*Ulmus americana* L.) showed symptoms of the disease most promptly and succumbed most rapidly of all species, potted plants of the species being completely killed within 10 days after inoculation. Death presumably is due to a toxin produced by the fungus, but the word "toxin" is here employed only in a nonspecific sense. Studies previously reported by others, as well as the writers' investigations, indicate that microscopic symptoms indistinguishable from those resulting from fungus infection may occur in plants variously treated with sterilized extracts from fungus cultures. If the symptoms are associated with a specific toxin, a neutralizing agent may be found, although no consistently reliable agent has been found by the writers.

Considerable interest in the work has been shown by municipal tree departments and private citizens, and many specimens for laboratory study were received during the past year. Through the cooperation of the United States Bureau of Entomology and Plant Quarantine, valuable information relative to the general distribution of the disease has been obtained regularly. Seven diseased trees have been eradicated in Massachusetts: in 1941, 1 in Alford; in 1942, 3 in Egremont, 1 in Great Barrington, 1 in Westfield, and 1 in Sheffield. The



eradication of diseased trees is under the direction of the State Department of Agriculture which has cooperated also in the entire program. The infection of trees in the southwestern part of Berkshire County and Westfield, Massachusetts, apparently does not indicate direct spread of the disease between these two regions within the State, but rather the introduction of the disease into the State at two separate points, presumably from a common source in the extension of the infestation radiating from the area around New York City.

In order to protect disease-free elms, concerted effort has been directed toward the elimination of freshly cut elm wood. At present this procedure is the most practical control that can be employed effectively in checking the spread of the disease. Since the disease fungus is virtually a prisoner within an affected tree, it cannot spread significantly except as it is carried from a diseased to an uninfected tree by a vector. The best evidence indicates that the smaller European elm bark beetle, *Scolytus multistriatus* Marsh., is the principal carrier insect. This insect invades the bark of weakened trees or freshly cut elm wood, where eggs are laid in galleries engraved between the bark and wood. Upon emergence, the beetles feed on healthy elm twigs and in this manner may facilitate fungus infection of healthy trees if the feeding beetles come from galleries in diseased wood. The beetle is now known to occur in Springfield, West Springfield, and Westfield in Hampden County, and widely in Berkshire County, in addition to the originally known eastern Massachusetts section of infestation which has been enlarged to include most of the area east of Worcester County.

The prompt destruction by burning of all freshly cut elm wood which is well suited for infestation by bark beetles is urged upon all agencies and individuals whose work brings them into contact with it, unless there is complete assurance that the bark will be removed immediately after the wood is cut or other provision is made for the consumption of any fungus-free wood as fuel in cooperative agreements. Tree wardens, foresters, arborists, fire wardens, highway departments, state departments, and public utilities have cooperated generously in aiding in this practical method of protecting disease-free elms. As in the case of all diseases of plants, however, unbroken continuity of the program is most essential.

*Other Tree Problems.* Sixty-three diseases of thirty-four species of trees, including nine diseases of elm, were identified from approximately 300 specimens and inquiries received during the year. The *Cephalosporium* wilt of elm was reported from 4 municipalities in which no previous cases of the disease had been reported, making a total of 177 cities and towns in which the disease has been found in Massachusetts. The fungus, *Verticillium* sp., was isolated from several species of woody plants, but no specimens were received from municipalities not included in the total of 96 reported for 1941.

Following an extended period of wet weather early in the growing season, leaf-inhabiting fungi caused considerable damage to foliage. Trees throughout Massachusetts were affected.

A nonparasitic disease of white pine, commonly known as needle-blight, in which needles of the current season discolor to varying degrees beginning near the tips, was rather prevalent both on ornamental trees and in plantations.

At the request of the Massachusetts Tree Wardens' and Foresters' Association, a report on wartime municipal tree programs was prepared, and subsequently a survey of tree diseases and other defects was made, with a view to outlining a program for tree protection and the prevention of damage by defective trees to persons and property. Current miscellaneous activities included the preparation of parts of the program of the annual Five-day Short Course for Tree Wardens, the compilation of a progress report, revision and publication of a manuscript on a *Peridermium* of northern hard pines, the discussion of the control of wood-

destroying fungi at the Eastern Pest Control Operators' Conference, the preparation of a mimeographed circular on "Trees in War," and the writing of newspaper press releases. Publications referred to are found listed at the end of this bulletin.

**Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modification of Environment.** (W. L. Doran.) As a result of increasing interest in the beach plum, a native plant heretofore relatively neglected, work is now being done in cooperation with J. S. Bailey of the Department of Pomology on its vegetative propagation, and an article on the subject was recently published. There was no rooting of hardwood stem cuttings, but softwood cuttings rooted fairly well and best (67 percent in 25 days) when taken here in mid-June and treated with indolebutyric acid (50 mg./l., 24 hr.). Work with root cuttings taken in the fall is now in progress.

The vegetative propagation of garden sage, a plant not now available to spice manufacturers from the usual European sources, was investigated in cooperation with A. M. Davis of the Division of Horticulture, and an article published. Untreated cuttings taken in winter rooted well in sand-peat or sandy soil, better than in sand; but their rooting was hastened or improved by treatment for 24 hours with 1 naphthaleneacetic acid or indolebutyric acid 25 mg./l.

None of the treatments (red cuprous oxide, Barbak D, zinc oxide, Spergon, and Semesan) which were applied to seeds of trees sown in a cold frame in March gave wholly satisfactory protection against infection of seedlings by soil fungi. So far as there were differences in final stands, they were in favor of the use of red cuprous oxide with blue spruce, Barbak D with white pine, and zinc oxide with hemlock, arbor-vitae, Douglas fir, and sycamore.

In propagation by cuttings, it is important to know which species need no treatments with root-inducing substances. It is noteworthy, therefore, that August cuttings of *Actinidia arguta* and February cuttings of *Decaisnea Fargesii*, both of which bear edible fruit, also February cuttings of *Viburnum rhytidophyllum*, rooted 100 percent without treatment.

Cuttings of Norway spruce are not very responsive to treatment with the commonly used root-inducing acids. But the rooting of February cuttings of two varieties, *pygmaea* and *nana*, was hastened and improved by treatments with solutions of manganese sulfate, 1.0 percent and 5 hours for the former, 0.5 percent and 24 hours for the latter. Rooting of late fall or early winter cuttings of Norway spruce, variety *nana*, as well as cuttings of black spruce, yew, and Hinoki cypress was also improved or hastened by treatment with monobasic potassium phosphate 0.5 percent, 20 hours. Rooting of the last named was more improved by this treatment than by indolebutyric acid.

A mixture of sand and European sphagnum peat has been favored as a rooting medium, but an American sedge peat, similarly used, may give better results. January cuttings of *Lonicera syringantha*, treated with indolebutyric acid 50 mg./l., 24 hr., rooted 92 percent in a mixture (2:1) of sand and Florida sedge peat, decidedly less well in a similar mixture of sand and European sphagnum peat.

To determine the possible effect of a powder-dip treatment in combination with and immediately after solution-immersion treatments, cuttings of Chinese juniper (the variety *torulosa*) taken in February were variously treated. Untreated cuttings rooted only 11 percent. There was 83 percent rooting of cuttings treated with Hormodin No. 3 after treatment for 20 hours with indolebutyric acid 50 mg./l. or naphthaleneacetic acid 25mg./l., while cuttings given only the solution treatments rooted not more than 50 percent.

As compared with our knowledge of soil disinfection prior to seeding, there has been relatively little information available about the disinfection of rooting media for cuttings. When a rooting medium, sand-peat, was disinfected by

steaming, by formaldehyde, or by vinegar within 24 hours before the insertion of winter cuttings, there was injury to arbor-vitae, red cedar, Hinoki cypress, yew, and two species of Ilex. Similar treatment of the rooting medium with steam or formaldehyde four days before the insertion of cuttings was also harmful or of no benefit. Such treatments are apparently more toxic to cuttings, even dormant cuttings, than to some seeds and it is evident that there should be considerable delay between the disinfection of a rooting medium and the planting of cuttings.

Cuttings of white pine, made of the previous year's growth, were taken in late winter. They rooted neither more nor less well in sand-peat previously used for this purpose, or in sand-peat to which soil from under pine trees had been added, than they did in new sand-peat, never before used, or in new sand-peat steam-sterilized fifteen days previously. Fungi in the rooting medium are, it appears from this, without effect on the rooting of cuttings of white pine. Cuttings from different white pine trees differ in rooting capacity, and treatments which improve the rooting of cuttings from some trees are without much or any effect on the rooting of cuttings from others. Rooting of cuttings from some trees was improved by relatively short solution-immersion treatments in relatively concentrated indolebutyric acid or naphthaleneacetic acid solutions, by powder-dip treatments with Hormodins No. 2 and No. 3, and by combinations of solution-immersion and powder-dip treatments.

**Effect of Chromated Zinc Chloride on Plants.** (L. H. Jones.) The scarcity of lumber which is naturally decay-resistant has led to the use of a chemically treated substitute. This has been successful in the case of telephone poles, railroad ties, building supports, etc. However, when such chemically treated lumber was used in the construction of benches in which plants are grown in the greenhouse, results have indicated that the wood preservative may be toxic to the plants, instead of only to the fungi and bacteria which cause decay.

In tests made here, where chromated zinc chloride was used as the preservative, injury to growing plants was very common and was most pronounced during the warmer months and with the more acid soils.

**Study of Diseases of Plants Caused by Soil-Infesting Organisms, with Particular Attention to Control Measures.** (W. L. Doran.) Seed treatment with a mixture of oxyquinoline sulfate and talc (1:1) markedly improved stands, but seed treatment with a mixture of potassium dichromate and graphite (1:1) gave even better results; as good results, in fact, as did Semesan, Spergon, or red copper oxide with cucumber, cress, beet, tomato, and chicory. Only with pea did Spergon give better results than potassium dichromate. With tobacco, red copper oxide as a seed treatment gave the best results, Spergon the poorest; but none of the seed treatments gave as good results as did formaldehyde treatment of soil.

Sodium nitrite, 1.5 to 3.0 gm. per square foot, applied to soil immediately after seeding, was injurious to crucifers and to pea, not to cucumber, beet, and chard, and it markedly increased the number of plants which lived. Lacking anything better, it could be used as a soil fungicide with some plants, but it did not give good results as did much lighter applications of potassium dichromate.

Chromates and dichromates of potassium, ammonium, and sodium, applied in solution to soil immediately after seeding, were found to be highly effective soil fungicides, as effective as formaldehyde even in light applications. And, if properly used, they were quite safe as regards effects on germination and growth of seedlings, except with cabbage and other crucifers. Potassium dichromate, 0.4 to 0.45 gm. per square foot (about 43 pounds per acre), was usually enough for protection and great improvement in the stands of seedlings whether the pH value of the soil was 5.6 to 7.1, that is, whether the soil was from a slightly acid to a



growth in the acid than in the slightly alkaline soil. Dichromates usually gave somewhat more complete protection and, if used in unnecessarily heavy applications, retarded growth of seedlings more than did the chromates. But if applied at the time of seeding and at the rate of not more than 0.45 gm. per square foot, the chromates and dichromates of potassium, sodium, and ammonium were without ill effect on cucumber, beet, chard, pea, and bean; and the chromates of potassium and ammonium, especially the latter, gave very good results. Potassium dichromate was most effective and safe when applied to soil immediately after seeding. Applied 24 hours later, it retarded germination of seeds of some species. It gave satisfactory control when applied to soil two weeks before seeding but was less effective when applied more than three weeks before seeding. Chromate and dichromate of potassium, as used, gave more complete protection than did the corresponding salts of sodium. Chromic acid gave superior results only with beet; and the chloride, nitrate, and sulfate of chromium were almost completely ineffective.

Cresol, in as light an application as 1.5 cc. per square foot, immediately after seeding, gave good control, almost as good as did formaldehyde.

A very light application of formaldehyde (4.9 cc. or one teaspoonful per gallon of water) was most effective when applied to soil immediately after seeding, decidedly less effective when applied more than 24 hours after seeding. Growth of beet, cucumber, and lettuce was improved by applications made not more than 8 hours after seeding, but seedlings of pea were injured when the first application was made 24 hours after seeding.

When nutrients in the form of potassium nitrate and precipitated bone or Ammo-Phos were added to a solution of formaldehyde and applied to soil at the time of seeding, the fungicidal action of the formaldehyde was unimpaired. But in a good sandy loam, the growth of seedlings of pepper, eggplant, beet, and cucumber was improved as much by formaldehyde alone as by formaldehyde plus the nutrients.

Starter solutions applied to the soil around tomato plants as they are set in the field cannot, without danger of chemical injury to the plants, carry enough formaldehyde to be effective against soil fungi.

Lacking chemicals, seeds of some kinds, not all, may well be sown on a layer of sphagnum, overlying soil. Damping-off was well controlled in this way, although not so completely as by formaldehyde treatment of soil. Sphagnum so used gave good results with lettuce, cabbage, and cress, the two latter being especially susceptible to injury by formaldehyde; but sphagnum did not give good results as regards either stands or growth of the solanaceous plants, pepper, eggplant, and tobacco.

**Chemical Soil Surface Treatments in Hotbeds for Controlling Damping-off of Early Forcing Vegetables.** (W. L. Doran, E. F. Guba, and C. J. Gilgut.) This study was completed with the publication of Bulletin 394.

In some additional tests, certain newer chemical materials offered as seed protectants, notably Spergon, Thiosan, yellow cuprous oxide, and tri-basic copper sulfate, showed in many instances value equal to or surpassing Semesan, red cuprous oxide, and zinc oxide on a wide variety of flower and vegetable seeds.

**Control of Greenhouse Vegetable Diseases.** (E. F. Guba, Waltham.) The various types of tomatoes studied for their reaction to *Alternaria* early blight were also tested for their susceptibility to *Cladosporium* leaf mold. Among them seven types were found showing a very slight degree of susceptibility indicated by sparse, yellowish areas without sporulation, molding, or necrosis, and one type showing none of these symptoms and from all appearances immune. In addition,



all six selections of *Lycopersicon peruvianum* (L.) Mill. showed a similar type of immunity. Bulletin 393 embodies the progress and results of several years' work in the development of resistance in tomatoes to *Cladosporium*. The Bay State variety is showing susceptibility to the new strain of *Cladosporium* in an increasing number of greenhouses. Nevertheless, many growers have accepted the new variety as a choice forcing tomato. Now that resistance to the new or Bay State strain of *Cladosporium* has been found, it is being utilized in an effort to combine resistance with desirable commercial type.

**Resistance to Tomato Alternaria Early Blight.** (E. F. Guba and R. E. Young, Waltham.) Seed of some 37 elementary types of tomatoes offered as possessing significant resistance to *Alternaria solani* (E. & M.) Jones & Groot were secured for trials at Waltham. These tests were purely exploratory, and if suitable resistance appeared, it was the intention to utilize it for breeding purposes in the development of a blight-resistant tomato. Since a large volume of copper fungicides is employed in the control of tomato early blight, this study would appear to represent a worthy contribution to the war effort.

Weather conditions were ideal for the development of early blight, but in spite of repeated artificial inoculations the disease rather consistently became epidemic only in correlation with a heavy load of fruit and maturity of the fruit. Thus many types remained relatively free of the disease until late in the season and then showed it in severe proportions. The largest and heaviest fruited and earliest maturing types consistently showed a high degree of susceptibility, and only nine types showed resistance.

**Interrelation of Wettable Sulfur, Lead Arsenate, and Lime in Apple Spraying.** (Departments of Botany, Chemistry, Entomology, and Pomology cooperating.) This project is intended to add to our knowledge of insect and disease control and to assist in making improvements in the apple spraying schedule. On this basis special consideration was given to tenacity of sulfur, scab control, spray injury, and insect control.

**Disease Resistance and Heredity of Carnations.** (E. F. Guba cooperating with H. E. White, Waltham.) Eighteen varieties of carnations were scrutinized for their susceptibility to various important fungus diseases. As was to be expected, in view of the wide host range of *Rhizoctonia solani*, no resistance to this fungus was found.

Twenty-two varieties were studied for their reaction to *Alternaria dianthi* (blight). Virginia, New Deal Ward, Minna Brenner, and Hazel Draper showed a moderate to high degree of susceptibility, but not until long after the benching season. The disease has become increasingly insignificant in recent years.

A high degree of susceptibility to *Uromyces* rust was shown by Woburn, Olivette, New Deal Ward, Hazel Draper, Paragon, Pink Treasure, Johnson's Crimson, Spectrum Supreme and King Cardinal.

Tests with the branch rot organism, *Fusarium dianthi*, and the root rot organisms, *F. avenaceum* and *F. culmorum*, yielded no results.

**Effect of Soil Temperature on Timothy (Phleum pratense L.).** (L. H. Jones.) Seedling plants of timothy were transplanted to containers of soil at a high level of fertility. The plants were allowed to establish themselves at a soil temperature of 65° F., after which the apparatus was adjusted to a range of soil temperatures from 50° to 90° at 10-degree intervals. Tiller counts at 50 days showed that soil temperature affected stooling, the number being greater at 70° and tapering off to the extremes of 50° and 90°. At 50° there was a marked tendency for the shoots to be prostrate in habit. This prostrate habit was also noted in a cool greenhouse

with bronze grass (*Bromus inermis* Leyss.), meadow fescue (*Festuca elatior* L.), perennial rye grass (*Lolium perenne* L.), and timothy (*Phleum pratense* L.).

The number of tillers was closely associated with the height of the plants, those at 70° F. being the tallest at 50 days. Foliage and stem color were affected by soil temperature. The plants at 50° were a dark green, and those at 60° were intermediate between the dark green at 50° and the light green at 70° and above.

There were enough replications so that half the containers were available for shifting of temperatures, the remaining half being kept at the same temperature as at the start of the test. The shifted temperatures were 20 degrees higher or lower than the original temperatures. By this means it was possible to corroborate the earlier conclusions made at the 50-day period. Plants which had been at 50° F. and were dark green, prostrate in habit, short, and with few tillers, responded soon to the 70° soil temperature by assuming the characteristics of the check at 70°. On the other hand, the plants at 70°, when shifted to 50°, became prostrate in habit, dark green in color, and stopped growing. At temperatures of 80° and 90°, the check plants and those shifted from 60° and 70° were not in a healthy state of activity; but the unhealthy plants shifted from 90° to 70° and from 80° to 60° resumed the healthy appearance of the check plants for these temperatures.

In the final stages, the plants at 90° F. soil temperature were very poor. Several had died and the remainder were stunted and dark green in color. The plants at 50° and 60° had the most and tallest spikes, but the foliage at the base was sparse. The plants at 70° had thick foliage at the base indicating continued vegetative activity. These plants also had the greatest dry weight. It also appears that soil temperatures lower than 70° give greater dry weights than those above 70°. Since careful attention was given to supplying water, the experiment indicates that soil temperature is the governing factor, and not drought, which is frequently associated with long hot spells of weather.

## DEPARTMENT OF CHEMISTRY

Walter S. Ritchie in Charge

**Chemical Investigations of the Onion.** (Emmett Bennett.) The preliminary work on the characterization of the soluble carbohydrates of the Ebenezer onion as reported last year has been extended. The titration of the hydrolyzed sugars with standard iodine and alkali and the determination of the fructose both indicate that the total sugars are approximately two-thirds d-fructose. Syrups of the total hydrolyzed sugars yielded crystals with a specific rotation of  $[-41^{\circ}]_D^{20}$ , which is of the order expected for a mixture of d-glucose and d-fructose in the ratio of 1 to 2.

By removal of the reducing sugars, a preparation was obtained having a specific rotation of about  $[+48^{\circ}]_D^{20}$ , and after inversion about  $[-17^{\circ}]_D^{20}$ . This, together with the large negative enhancement noted on solutions after inversion, is a strong indication that the chief non-reducing sugar is sucrose.

The present work is concerned with metabolic changes which occur in the cell during growth. Samples were taken at intervals during the growing season. At mid-season onions were collected and divided into equal groups, some of which were placed in total darkness for different periods of time. The many forms of nitrogen have been determined as well as the sulfur compounds, organic acids, and carbohydrates.

Some of the chemical changes during normal growth are as follows: Total nitrogen and organic acids decreased as the season progressed; soluble nitrogen and total sugars increased. The increase in total sugars continued until the middle of the season. Up to that time the trend was the same for both reducing and non-reducing sugars; thereafter the main change appeared to be the formation of non-reducing sugars.

The results of the culture work in complete darkness are almost completely opposite those of the control. In darkness the content of solids, total nitrogen, water soluble nitrogen, organic acids, and carbohydrates decreased gradually.

**The Hemicelluloses of Forage Plants.** (Emmett Bennett.) Previous work at this station has indicated that a considerable difference exists in the content of moisture of forage grasses. An investigation of the polyuronide hemicelluloses of two species, sheep's fescue (*Festuca ovina*) and sweet vernal (*Anthoxanthum odoratum*) which represent grasses of low and high moisture content respectively, indicated that this difference may be due chiefly to this group of substances. The greater content of total hemicelluloses was found in the low-moisture grass, and the nature of these groups in the two species was quite different.

The hemicelluloses of each species, when hydrolyzed, yielded mainly a uronic acid, l-arabinose and d-xylose in the approximate molar ratio of 1:0.2:15.7 in sheep's fescue and 1:2.9:9.3 in sweet vernal. A preliminary examination of the viscosity of the hemicelluloses indicated that those from sweet vernal grass when dispersed in water produced not only the more viscous system, but also the more stable system. Those from the sheep's fescue for the same period and under the same conditions were almost completely flocculated. It would appear, therefore, that the degree of hydration of the two products differs considerably, and that the species containing the more highly hydrated product has the greater original moisture content and contains the larger percentage of l-arabinose.

**Lignin and Its Relation to Absorption of Minerals by Plants.** (Emmett Bennett.) Special attention has centered around the mobilizing power of isolated lignin as a representative of the residual organic matter in the soil. While it is known that organic matter may absorb free ions in the soil, its role as a mobilizer of ions is not so well established. To determine the possibilities of lignin in this capacity, a container was devised which would hold both the inorganic material (calcite) and the suspension of lignin in contact with each other and allow the suspension to be agitated with a power driven stirrer, to renew the contact, without disturbing the calcite. The lignin was freed from mineral acids by electro dialysis. The extent of mobilization could be noted from time to time by the losses in the weight of calcite. Calculations based upon such a procedure indicated that mobilization did take place over a period of several months in amounts equivalent to a base exchange capacity of about 175 milli-equivalents per 100 grams of lignin. This phenomenon indicates that the residual organic matter as such may mobilize ions from insoluble compounds. A practical application may be in the form of contact depletion.

On the assumption that the high base exchange values of soil organic matter are due to previous oxidations, samples of lignin were oxidized by iodine. Iodoform was obtained as one by-product. The oxidation value amounted to 175 ml. of N/10 iodine per gram of lignin. Base exchange values of the oxidized lignin were about 35 percent higher than those of the control.

Attempts were made to determine the nature of the functional groups most active in base exchange activity by blocking the aromatic hydroxyl group with acetyl groups. This, while not wholly satisfactory, indicated that the hydroxyl groups were chiefly responsible.



**Chemical Changes in Cooking Quality of Vegetables.** (Monroe E. Freeman.) A quantitative method for measuring the texture of baked potato tissue by estimating the pore space of dried slices was found to be satisfactory. The method was applied to the study of texture changes in tubers during winter storage. Samples stored at 35° and 50° F. for 76 days, 130 days, and 161 days were baked and the texture was measured or estimated by three methods. Center rot and "blackening" appeared in so many tubers that conclusive results were not obtained. From the sound samples available, however, there seemed to be very little change in specific gravity during the storage period. A visual scoring method indicated that the cooking quality, i.e., texture, was lower in tubers stored for longer periods and at the lower temperature. Toluene index of the tubers indicated a small decrease in baking quality with time of storage at the higher temperature, but because the samples were incomplete these results cannot be assessed with any certainty.

**Physico-Chemical Properties of Starches.** (Monroe E. Freeman.) The anomalous heat capacities of starch-water systems reported in 1941 were carefully studied and applied to dextrin-water systems and to sand and water. The data allowed a clear explanation of the phenomenon and its relation to the bound water in lyophillic colloids and indicated the existence of a general phenomenon of lyophillic systems that hitherto has not been clearly recognized.

**The Influence of Base Exchange Capacity and of Exchangeable Ions in Massachusetts Soils on the Availability of Potassium.** (Dale H. Sieling.) Pot cultures of synthetic soil for plant growth were prepared by mixing quantities of a typical tobacco soil, the Agawam fine sandy loam, with electrolyzed bentonite which had been adjusted to fixed calcium levels with calcium hydroxide. These cultures were all of the same reaction and varied considerably in their base exchange capacity. Four levels of base exchange capacity, 7.1, 12.0, 17.0, and 22.0 milli-equivalents per 100 grams, were established. At each base exchange capacity level the soils were fertilized with four different quantities of potassium and with a fixed quantity of both phosphorus and nitrogen. Nitrogen was also added at various times during the growth of the plants. Each culture was prepared in duplicate and contained 7000 grams of synthetic soil. Tobacco, Havana Seed 211, was used to test growth response and nutrient uptake. One plant was grown in each culture and the soils were watered with distilled water whenever the rainfall was inadequate.

Luxuriant growth was obtained in all cultures and there were no apparent nutrient deficiencies or excesses. Growth, as indicated by the dry weight of the plants, was increased very little by addition of gypsum. The cultures having an exchange capacity of 17.0 milli-equivalents gave plants of the highest average weight. There was a tendency for the dry weight of plants to increase as the quantity of potassium increased at each exchange capacity level.

**The Fixation of Arsenic in Soils and the Influence of Arsenic Compounds on the Liberation of Fixed Phosphate.** (Dale H. Sieling.) Very marked differences in sorption of phosphate and arsenate were observed when ballmilled Kaolin was used as the sorption substance. When 1-gram samples of ballmilled Kaolin were shaken for two days with increasing quantities of sodium arsenate at pH 3.0 in 10 ml. of solution, there was a linear increase in the arsenate sorption up to about 13.0 milli-equivalents per gram for a solution having 42.5 milli-equivalents. At higher concentrations there was a sharp increase in the amount of arsenate sorbed followed by progressively smaller increases in the pattern of a typical adsorption. When 1-gram samples of Kaolin were shaken for seven days with solutions of the same concentrations, instead of for two days, the sorption



followed an entirely different pattern. As the concentration increased, the sorption followed a smooth curve until 12.3 milli-equivalents per gram were sorbed from a solution containing 40.0 milli-equivalents. As the concentration increased above this point, there was a marked decrease in the sorption of the arsenate and also a considerable increase in the volume of Kaolin (from 1.7 ml. to 5.0 ml. per gram). The amount of arsenate sorbed remained constant at 10.8 milli-equivalents per gram between the concentrations of 40 and 50 milli-equivalents per 10 ml. of solution and then increased rapidly in a true adsorption pattern up to 24.1 milli-equivalents for a solution containing 80 milli-equivalents of arsenate ion. It seems likely that both arsenate and water are sorbed by the Kaolin and at the critical concentration of 40 to 50 milli-equivalents per gram, the water is sorbed more, thus causing the tremendous increase in volume of clay and making it appear as though arsenate were not being adsorbed when one uses the solution concentration as an index of the sorption.

The same type of experiment was made with phosphate solutions and a typical adsorption curve was obtained for this ion. No apparent increase in volume was noticed at any concentration of phosphate and the maximum sorption was found to be about 12.4 milli-equivalents of phosphate per gram of Kaolin. This ion apparently does not have the marked hydrating effect exhibited by the arsenate ion, although it is sorbed in considerable quantity.

**The Effect of Orchard Mulches on the Plant Nutrient Elements in the Soil.** (Dale H. Sieling and J. K. Shaw.) Three test plots were established in the summer of 1941 to determine whether mulching with hay and glass wool had any effect on the mobilization of the plant nutrient elements of orchard soils. One plot received a two-inch mulch of Fiberglass wool, the second received a liberal application of meadow hay, and the third was surface-cultivated to prevent the growth of weeds. One year after the initiation of the experiment soil samples were obtained from four depths in each of the test plots and analyzed for exchangeable bases and available phosphorus. No material change had taken place in the plant food content of the soils at any depth after one year of the treatments. These results were to be expected since there had been very little decomposition of the hay mulch. More hay has been added to the plots which are to receive hay mulch and samples will be taken for analysis from all of the plots again next year.

## CONTROL SERVICES

P. H. Smith in Charge

The fertilizer, feed, seed, and dairy laws are administered as one service and the operations of each of these, with the exception of the dairy law, are completely reported in annual bulletins issued for that purpose.

Besides the regular control activities the laboratory, through its staff, cooperates liberally on numerous research projects active in other departments and also performs many analytical and testing services for State institutions and for private citizens who, because of the nature of their problems, deserve this consideration.

Under the dairy law 5,984 pieces of Babcock glassware were tested and 107 Certificates of Proficiency were issued during the year ending December 1, 1942.

The enlarged emphasis on the vitamin values of all feeds, and commercial feeds in particular, and the increased interest in the manganese content of poultry mashes and in the protein quality of meat and fish products used for feed demands

continual expansion of the analytical service in those fields and, in an attempt to define these values, several special circulars were published during the year in order that the feeder might extend intelligent and deserved consideration to these recently recognized beneficial factors in feed products.

## THE CRANBERRY STATION

East Wareham, Massachusetts—H. J. Franklin in Charge

The season's cranberry crop was the second largest in the history of the industry, both in Massachusetts and in the United States. There was rather more rot among the berries as they came from the field in this State than has been evident in any other year, and the abnormal decay showed a marked tendency to continue in storage. Fortunately, a lively demand for the berries throughout the selling season, both for commercial canning and as fresh fruit, moved the crop promptly.

### Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.)

*Hill Fireworm (Tlascala finitella (Walker))*. Moths of this species emerged in confinement very late in May and were caged with cranberry branches on May 30. On June 13 many small caterpillars were found to have hatched from eggs that had been laid during the interval. Some of these were as much as a twelfth of an inch long and had done considerable feeding, so they may have been three days old, indicating that the eggs hatch about ten days after they are laid. Some unhatched eggs were found, most of them on the stems of the new cranberry growth. They were oval in outline, much flattened against their support, and about a fortieth of an inch long. The young worms had blackish heads and very faintly striped reddish brown bodies.

The Burrage bog, infested with this insect last year, was examined on June 16. The worms there had channeled some of the cranberry stems toward and to the tips causing them to drop over. Occasional worms, already showing their striping were sewed up in the cranberry tips like black-headed fireworms, but with more frass around them. The infestation on this bog was again quite serious.

*Spotted Fireworm (Cacoecia parallela (Rob.))*. This pest broke out severely on about nine acres of bog in Marion, Mass., early in June. Most of the worms matured by July 8, but some remained till after July 16 when the moths had begun to fly. The infestation was well controlled by dusting with 30 pounds of cryolite to an acre on June 25.

Nine species of parasites were reared from this pest, the most prevalent being *Itoplectis conquisitor* (Say), of the order Hymenoptera, family Ichneumonidae; and *Nemorilla floralis* (Fallen), of the order Diptera, family Exoristidae. All the others belonged to the order Hymenoptera, four being Ichneumonidae and three Chalcidoidea.

The spotted fireworms fed on the following weeds on and around the infested bog: chain fern, sensitive fern, marsh shield fern, common brake, flowering fern, saw brier, hardhack, chokeberry, coarse bramble, winterberry, marsh St.-John's-wort, sweet pepperbush, swamp blueberry, sheep laurel, loosestrife, and asters. Loosestrife and marsh St.-John's-wort were evidently favorite food plants of the insect. They were very abundant on the bog and may have largely induced the infestation.

Some pupae of the spotted fireworm squirm vigorously when disturbed, but they are more often inactive. Each of the abdominal segments of the pupa, except those toward the posterior end, has two ridges across the upper surface

with the surface between them very smooth, each ridge bearing a single row of many short, sharp, tooth-like spines pointing obliquely backward.

*White Grub (Phyllophaga)*. Young grubs, evidently hatched in June, were found rather abundant in a small area on the station bog on July 13, 1942. They were quite active and all within an inch or two of the soil surface, most of them within an inch of it.

*Cranberry Spittle Insect (Clastoptera)*. The young nymphs in their spittle were found as early as June 2. Flooding a bog for 24 hours as soon as an occasional flower had opened wiped out a heavy infestation completely without harm to the vines or crop. This seems to be an excellent treatment.

*Cranberry Root Grub (Amphicoma)*. Half of the station bog was treated with seven ounces of sodium cyanide in 100 gallons of water, a gallon to a square foot, late in April and very early in May. The treatment was very successful and did not reduce the crop. It hurt the vines only on a few small areas. Flood water drained from this bog eight days after the application had no poisonous effect.

Army worms (*Leucania*) attacked freely several bogs that had been flooded from mid-May to mid-July to control the root grub.

*Grape Anomala (Anomala lucicola Fab., formerly reported as Anomala errans)*. Five acres of sericously infested bog, located in the Wenham section of Carver and not heretofore known to be affected by this grub, were treated very successfully with sodium cyanide solution.

*Cranberry Tolerance of Certain Materials*. Long experience has found cranberry vines very intolerant of sulfur but very tolerant of kerosene and fairly so of copper.

Cryolite, four tons to an acre, was applied to small areas of the station bog on June 20, 1941. Injury from this was very slow in developing but had become severe by July 1942.

A mixture of 4 pounds of calomel and 96 pounds of talc, 100 pounds to an acre, was dusted onto plots of Howes vines on July 1, 1941, with the vines then approaching full bloom. The set of fruit and size of berries were not much affected, the crop turning out to be about as abundant as on the bog around the plots; but the treatment greatly delayed the ripening of the berries and they finally failed to develop a good red color. The berries were picked toward the end of September and were examined chemically and spectroscopically for mercury, but none was found. The vines on these plots were not quite so green in the fall of 1941 as those on the bog around them, and a rather noticeable number of scattered branches died. The treated areas had a normal appearance during the 1942 growing season, but they bore only about a third as much fruit as areas of the same size around them.

#### *Prevalence of Cranberry Insects in 1942.*

1. Bumblebees and honeybees were abundant everywhere on Massachusetts bogs during the cranberry flowering.

2. Infestation by Gypsy Moth (*Porthetria*) was light in Plymouth County and moderate on most of the outer Cape.

3. Cranberry fruit worm (*Mineola*) was about normally abundant, more so than in 1941.

4. Black-headed fireworm was normally abundant, more so than in 1941.

5. Firebeetle (*Cryptocephalus*), almost none.

6. Yellow-headed fireworm (*Peronea*) was more troublesome than usual in recent years.

7. Spotted fireworm was generally more abundant than for many years.
8. Lady beetles were unusually prevalent.
9. False armyworm (*Xylena*) was very prevalent, about as in 1941.
10. Blossom worm (*Epiglaea*) was much less than normally abundant.
11. Spanworms were about as usual.
12. Cranberry girdler (*Crambus*) was more harmful than normal.
13. Cranberry weevil (*Anthonomus*) was about as in other recent years.
14. Cranberry spittle insect and tipworm were fully as troublesome as usual.

**Control of Cranberry Bog Weeds.** (Chester E. Cross.) In all, 155 plots were used during the season to test the value of various herbicides. The more interesting results follow:

**Kainit.** This potash fertilizer has been advocated as an herbicide for poison ivy and has been used extensively in Europe to destroy charlock and wild mustard in plantings of spring cereals. Results with 56 plots to test its value as a cranberry bog herbicide were not encouraging. No injury to either cranberry vines or weeds followed its use in amounts up to 1000 pounds an acre when the foliage was dry; and enough to burn weeds like poison ivy, loosestrife, beggar-ticks, horsetail, or asters with their foliage wet damaged cranberry vines also.

**Zotox** is widely advertised as a selective weed killer for eradicating crab grass and various broad-leaved perennials from lawns and fairways. Different amounts of solution of this chemical in various concentrations were tried on 46 plots against some of the more common bog weeds. It proved to be valueless as a bog herbicide, not being effective even on crab grass unless enough was used to injure cranberry vines badly.

**Ferrous Sulfate.** A solution of this chemical<sup>1</sup>, a pound to a gallon of water, 400 gallons to an acre, was very effective on low cudweed, with little injury to cranberry vines. This weed is often a serious pest on new plantings and on bogs where grubs have caused areas to be bare of vines.

**Kerosene.** About 20 plots, on a bog flowed for root grubs till July 15, were treated with kerosene between August 2 and 12. A thick mat of crab grass was almost completely destroyed with 200-300 gallons an acre. The same amount killed baryard grass, spreading witchgrass, and warty panic grass very effectively. Little harm was done to the relatively tender cranberry vines, most of this injury being on plots treated during the middle of the day or when the vines were wet. The time of day the treatments were made did not affect the killing of the weeds.

**Ammonium Sulfamate.** Results of dry applications of this new chemical on cranberry bogs have been reported heretofore.<sup>1</sup> This year it was tried in solution as a spray and gave some promise of being a useful herbicide for poison ivy, loosestrife, chokeberry, feather and sensitive ferns, and asters, when used at a rate of not more than one pound in eight gallons of water. Stronger solutions, unless applied in small amount and with great care, were usually very harmful to cranberry vines. Not enough work has been done with this chemical to justify conclusions. It is peculiar that, when cranberry vines have been injured by its use, new growth is slow to develop and its leaves are discolored and undersized, this perhaps indicating that the injury is greater than appears. Partly grown cranberries sprayed with ammonium sulfamate solutions reddened noticeably in a few days without showing other definite signs of injury.

<sup>1</sup>Mass. Agr. Expt. Sta. Bul. 378:47, 1941.



*Herbarium.* A collection of 140 species of the more common bog weeds has been assembled at the Cranberry Station. It will be useful in identifying weeds for cranberry growers.

**Blueberries.** (H. J. Franklin.) Only 163 quarts of berries were gathered from the station's cultivated patch in 1942. This small crop is explained by the severe freeze that occurred the night of January 10-11 when the temperature at East Wareham fell to 24° F. below zero, probably the lowest at this place in the last 55 years. The interior of all the fruit buds in the blueberry patch became more or less blackened within a day or two. The subsequent fruiting of the different varieties showed that they varied greatly in their tolerance of the cold:

Adams, Cabot, June, Jersey, and Stanley bore no berries.

Katherine, Pioneer, Rubel, and Wareham produced less than half a crop.

Concord bore half to two-thirds of a crop.

Harding and No. 73 (Station culture number) were reduced only moderately from a full crop. This shows clearly the hardiness of the Harding variety and adds to other great values of No. 73 (a Harding-Rubel cross).

Twenty of twenty-six seedlings of a Harding-Rubel cross developed most of their crop, while 44 of the 59 full-grown miscellaneous plants failed to yield any fruit.

It was finally estimated that the crop of the station blueberry patch, as a whole, was reduced 80 percent by the freeze. However, the blueberry bushes were little injured anywhere by this cold, only the fruit buds and tender tips being hurt, thus evidencing the fact that they approach the wild blueberry in winter hardiness.

## DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

**Studies on Chocolate-Flavored Milk.** (W. S. Mueller.) The popularity of chocolate-flavored milk has grown greatly in recent years. Whether the addition of the chocolate flavoring enhances or decreases the nutritive value of the milk is a question which has been the subject of much investigation but has not yet been completely answered. The following progress in answering this question has been made.

1. *The Effect of Cocoa Upon the Utilization of the Calcium and Phosphorus of Milk.* (W. S. Mueller, with the cooperation of M. R. Cooney of Home Economics Nutrition.) The presence in cocoa of considerable quantities of oxalic acid suggested the possibility of interference with the utilization of the calcium of the milk or the diet, similar to that observed with spinach, beet greens, and other oxalic acid-rich vegetables. It also seemed advisable to determine whether or not cocoa interfered with the absorption of phosphorus, since milk contains a liberal amount of this important element, which is nutritionally closely associated with calcium. The results from an experiment in which 63 albino rats were used showed that the growth of the rats and their utilization of the calcium and phosphorus of milk were affected adversely by cocoa. It would seem, therefore, that the indiscriminate and excessive use of chocolate-flavored foods, especially in a diet low in calcium, should not be recommended.

2. *Effect of Cocoa on the Vitamin C Content of Milk.* (W. S. Mueller.) The addition of cocoa to milk hastened the destruction of vitamin C. This corroborates the results obtained in a preliminary study.

3. *Vitamin K Content of Cocoa and Dairy Products.* (W. S. Mueller.) It has been observed in the study on the availability of the iron of cocoa that the blood clotting time was shortened when the rats were fed cocoa. This observation led to an investigation of the vitamin K content of cocoa and dairy products. Of the various dairy and cocoa products fed, only cultured buttermilk and cocoa shell had any great effect on blood clotting time. These results indicate that the decrease in blood clotting time, which had been observed for rats receiving cocoa, is not directly tied up with vitamin K.

4. *The Tannic Substances of Commercial Cocoa Powders and the Determination of Cacao Purple.* (W. S. Mueller, with the cooperation of J. W. Kuzmeski.) Commercial cocoa powders have been analyzed for cacao purple by Ulrich's method. The average for 6 Dutch processed samples was 8.44 percent and for 9 unprocessed samples, 12.72 percent. The total ash of the ferric chloride precipitate varied from 11.48 to 18.24 percent. The ash of the precipitate consisted mainly of iron and phosphorus, present either as separate oxides or in combination as ferric phosphate. In general, Ulrich's method for the determination of cacao purple in cocoa products apparently leaves much to be desired. However, the results from this study indicate that the ferric chloride precipitate would measure the cacao purple content more nearly accurately if the washing procedure were modified and a correction made for the ash contained.

**Improving the Flavor and Keeping Properties of Milk and Some of its Products.** (W. S. Mueller.) Further work is being done on evaluating various substances as antioxidants for butterfat. At the outset of this study, the peroxide test was used in conjunction with the organoleptic tests for determining the effectiveness of the various antioxidants. As the work progressed, it became apparent that the peroxide test was not reliable for replacing organoleptic tests. A new chemical test (Chlorophyll Value Test by M. R. Coe, Eastern Regional Research Laboratory, Philadelphia) is being used for butterfat and seems to correspond more closely to organoleptic rancidity than the peroxide test. Today it is more important than ever before that we know how to prevent spoilage of butterfat because the product is being transported and stored under adverse conditions.

**A Study of Vanilla Sugars for Flavoring Ice Cream.** (W. S. Mueller.) The high price of grain alcohol is discouraging the use of ordinary vanilla extract for flavoring ice cream. Vanilla sugars appear to be a desirable substitute and their advantages and limitations for use in ice cream are being studied. Sixteen samples, including true, imitation, and mixtures of true and imitation, are being analyzed and used to flavor ice cream. In general, the vanilla sugars were found to be of excellent quality and appeared to be suitable for the purpose, and tests with consumers indicated that it was difficult to distinguish between the true vanilla and the imitation product.

**An Explanation of the Increased Efficiency of Gelatin in Ice Cream Mix When Initially Aged at 68°F.** (W. S. Mueller.) Results obtained in this study indicate that the initial aging temperature of 68°F. produced a more closely knit gel structure, which has many more inter-connected filaments than a structure produced by aging at the low temperature only. The more numerous gel filaments are effective in obstructing the formation of large ice crystals. This appears to be the most plausible explanation for the smoother texture of gelatin in ice cream when initially aged at 68°F. In view of the present national emergency, it seems particularly timely to emphasize the more effective use of gelatin.

**Iodoform Taste in Milk.** (H. G. Lindquist.) In a study made on off-flavors in milk, iodoform flavor was detected in a few samples. Investigation showed

that it was traceable to treatment of cows for retained afterbirth by the introduction of oil suspension of boric acid and iodoform into the uterus. One cow so treated secreted enough iodoform in her milk one week after treatment to contaminate 200 gallons of mixed pasteurized milk from the herd.

**New Stabilizing Materials for Ice Cream.** (A. M. Shipley, M. J. Mack, and J. H. Frandsen.) New stabilizers are constantly appearing on the market and arousing considerable interest because of the uncertainty of the supply of some of the commonly used stabilizers. Algatex, Kragel, Kremtex, and laboratory mixtures of monoglyceride and gelatin and of monoglyceride and Dariloid were compared with gelatin (190 Bloom) and Dariloid as controls, for their effect on ice cream mix and on finished ice cream. The results may be summed up briefly as follows:

1. With the exception of Kremtex, all the stabilizers studied were completely soluble at a temperature of 165°F.

2. Dariloid, Dariloid-monoglyceride, and Kragel were basic in reaction; gelatin, gelatin-monoglyceride, Algatex, and Kremtex were acid.

3. After aging 48 hours, the Algatex mix showed the greatest viscosity; the Dariloid-monoglyceride and Kragel mixes were next; and the gelatin, gelatin-monoglyceride, and Kremtex mixes showed the least.

4. None of the stabilizers affected the titratable acidity of the mix to any marked degree.

5. All except Dariloid, which had the least coagulating effect, affected the protein stability of the mix about the same.

6. All the mixes had about the same whipping rate, with no increase from the use of the particular monoglyceride used in these trials.

7. None of the stabilizers affected the flavor of the ice cream adversely.

8. Ice cream containing gelatin, Dariloid, Algatex, and Kragel had a satisfactory body and texture, but Kremtex seemed at times to produce a body that was slightly weak. The monoglyceride tended to make the ice cream firmer and drier and produced a crumbly body.

9. A smooth-melting ice cream was produced by all the stabilizers except Kremtex, which in some instances produced an ice cream that wheyed off slightly upon melting.

10. More than the usual amount of shrinkage occurred during storage when Kremtex and the monoglyceride mixtures were used.

**Bulk Versus Packaged Ice Cream.** (J. H. Frandsen and A. M. Shipley.) There is as yet no general agreement as to whether ice cream is better marketed in bulk or in packaged form. For reasons of sanitation and convenience, there is a distinct trend towards the marketing of foods in packages, and most of the arguments that apply to other foods are applicable also to ice cream. The results of this study thus far may be summed up as follows:

The amount of shrinkage incurred in the packaging of bulk ice cream is governed to a considerable extent by the serving technique and increases as the overrun of the ice cream increases. A 35 to 40 percent loss in volume results from bulk packaging as compared with packaging direct from the freezer.

Freezer-packaging produces an ice cream very definitely superior in body and texture to that packaged as bulk because it reduces temperature changes, does away with the forced pressure on the ice cream resultant from hand-packaging, and permits the packaging of ice cream in a desirable semi-soft condition. Machine-packaged ice cream can be held at a lower temperature than bulk ice cream and, therefore, keeps in better condition after it is sold to the consumer.

**Factors Affecting the Sweetness Perception in Ice Cream.** (J. H. Nair III and M. J. Mack.) A study was made of the percentage of butterfat, the source of butterfat, the ratio of fat to serum solids, the pH of the mix, the effects of salts present, the types of vanilla used, and the serving temperature of the ice cream and their effects on the sweetness perception in ice cream. The work has not been completed, but the preliminary study indicates the following conclusions:

There is a relation between sweetness and body and texture of ice cream.

The kind and amount of sugar in high-fat ice cream mixes definitely affect the quality of the ice cream. The use of corn syrup solids seems to prevent a crumbly texture and improves the body.

Temperature definitely affects the sweetness perception; soft ice cream tastes sweeter than hard.

## DEPARTMENT OF ECONOMICS

Philip L. Gamble in Charge

**Effects of the War and Readjustments in Massachusetts Agriculture.** (David Rozman.) This project is devised to take account of agricultural readjustments already in progress, with the expectation of facilitating the attainment of national goals in agricultural production and of providing a basis for a program of individual and public action after the present emergency is over.

So far the investigation has been directed toward obtaining a picture of readjustments in the dairy industry as the most important factor of agricultural production in the State. By analyzing data from the Animal Inspection records it has been possible to determine the distribution of cow herds in relation to their number and size in various sections of the State. Between January 1941 and January 1942, the total number of cows two years old and over on Massachusetts farms declined from 146,424 to 141,302. During 1941 there was a general decline in the number and proportion of smaller herds; while the herds with twenty cows and over increased both in total number and in the proportion of animals in the group. The distribution of cows by size of herds will have a major effect on the agricultural labor problem because, to the extent that production is concentrated in larger herds, there will be greater need for hired labor.

## DEPARTMENT OF ENGINEERING

C. I. Gunness in Charge

**Cranberry Storage Investigation.** (C. I. Gunness, H. J. Franklin, and H. F. Bergman.) The studies on storage of cranberries were continued during the fall of 1942. Samples of Early Blacks from the Experiment Station bog and from a commercial bog were stored in a commercial air-cooled screenhouse and in refrigerated experimental storage at two different temperatures, 45° and 35°. Both lots were picked on September 14, placed in storage immediately, and removed and screened on October 22. The storage and screening loss differed for the two lots of berries, but in both cases was greatest for the air-cooled storage and least for the refrigerated storage at 35°. There was much less difference between the two refrigerated storages than between the air-cooled and the refrigerated.

The berries from the Experiment Station bog were so well colored when picked that no appreciable change in coloring was noticeable in the different storages. Those picked from the other bog were "green" when picked. Those stored at



45° had colored best; those stored at 35°, least; and those kept in common storage were half way between.

Samples of Early Blacks from the Experiment Station bog were stored in a modified atmosphere in sealed sheet-iron cabinets in the refrigerated rooms held at 45° and 35°. This is a repetition of the trials made in 1941 and reported in the 1941 Annual Report. As explained at that time, it was difficult to remove the moisture produced by the respiration of the berries. This year more adequate means were provided for circulating the air from the cabinets through calcium chloride and no such difficulty was experienced. It was found, however, that the temperature inside the steel cabinets remained considerably higher than the temperature within the rooms in which the cabinets were placed. The cabinet in the 35° room had an average temperature of 43° and the one in the 45° room had a temperature of 50°. In comparing storage losses in the modified atmosphere with the losses in air, it was necessary to make allowance for these variations in temperature. While the results are by no means conclusive, they indicate a smaller storage loss in the modified atmosphere. It is obvious that this experiment cannot be carried out satisfactorily until a small sealed room is provided having its own refrigerating coil.

**Fruit and Vegetable Drying.** (C. I. Gunness in cooperation with Department of Horticultural Manufactures.) A small electric dehydrator was built during the summer of 1942 for use in the Department of Horticultural Manufactures. While planned for experimental work, the drier is of a size and design which makes it suitable for home use.

A variety of vegetables was dried during the summer and trials on the drying of cranberries are now in progress.

**Poultry House Investigation.** (C. I. Gunness and W. C. Sanctuary.) The housing project for 1941-42 showed an average water content of the litter varying inversely with the amount of insulation all winter from December 1 to March 11. On March 11 the water content of the litter from the non-insulated, partially insulated, and fully insulated pens was 36.6, 26.3 and 25.9 percent, respectively; the average number of birds was 77, 82, and 84; the food consumption from December 1 to February 9 was 24, 22, and 20 pounds per bird; and egg production 45, 42, and 41 eggs per bird. "Blue comb" disease and paralysis reduced production and caused considerable mortality. Each pen started in the fall with 100 Barred Rock pullets.

Horizontal and vertical temperature gradients were taken under electric hovers, some commercial and one home-made. The brooders producing the best results have a rather even temperature gradient from a low point at the outside edge of the hover to a high point in the center of the hover.

One commercial hover had a lower temperature over a rather large portion of the central area. This has been associated with a depression in the litter in the central area under the hover as if made by chicks crowding to keep warm. This particular hover has had high mortality, associated apparently with this crowding, on several occasions during severe cold snaps, sometimes early in the brooding period and sometimes during the latter part of the brooding period.

The study of soil heating cable to dry the litter in a brooder house equipped with an electric brooder was continued during the winter of 1941-42. While the litter can be dried by this means, it was necessary to rake the litter daily to get full value from the heating. Otherwise, the dry litter near the cable becomes a good heat insulator allowing very little drying at the top and permits caking at the surface. The extra work required, together with relatively high cost of current makes the practice impractical.

## DEPARTMENT OF ENTOMOLOGY

Charles P. Alexander in Charge

**Investigation of Materials which Promise Value in Insect Control.** (A. I. Bourne and W. D. Whitcomb.) Work on a cooperative project on investigations of dinitro combinations was concerned primarily with the effectiveness of such combinations against outbreaks of European red mite during the growing season.

A surprisingly heavy infestation of red mite developed in commercial orchards in practically all sections of the State. Evidences of mite abundance and beginning of injury to foliage were noted by mid-June. The attack developed steadily throughout June and reached its peak in most sections by late July and early August. Heavy bronzing of foliage occurred in many orchards, even on varieties which usually were not considered to be particularly susceptible.

Tests with a DN dust (a 1.7 dicyclohexylamine salt of DNOCHP) and a DN spray (a dicyclohexylamine salt of DNOCHP + dispersing and wetting agent, used at the standard recommended strength of 1 $\frac{1}{4}$  pounds per 100 gallons) were made in nearly all the blocks of the college and station orchard, and in several commercial orchards. Uniformly good control of the mites was furnished by both DN dust and DN spray, and where the applications were made with due care and under suitable spraying conditions no injury resulted.

Special studies of different strengths of the DN spray were made in a block of Baldwin and Wealthy trees. The material was applied at the rate of 12 ounces, 16 ounces, and 24 ounces per 100 gallons. All treatments gave good control of mites on both varieties. Some slight marginal burn was noted in a few cases, but this was so slight and occurred with such irregularity that it could not be definitely attributed to the treatment and was of no commercial significance.

Toxicity tests of the DN dust and of the DN spray upon 15 different types of ornamental trees and shrubs resulted in no measurable injury to the foliage of butternut, elderberry, flowering plum, willow, rose, ornamental crabapple, privet, barberry, Norway maple, red maple, evonymus (several varieties) or magnolia. Sumac, raspberry, and grape showed slight to appreciable injury. Fortunately these would seldom require summer application of insecticides of this type.

At Waltham a commercial DNOCHP material, known as DN-111 and containing approximately 20 percent of the toxicant, was used at the rate of 24 ounces and 12 ounces per 100 gallons of water on Baldwin apple trees infested with European red mite. The spray was applied July 23 when the mites averaged 12 to 16 per leaf. Both dosages gave good control, and no serious injury to foliage was observed although the margin of some of the tender leaves was slightly scorched. As a result of these experiments and others, DN-111 appears to be a very satisfactory material for the control of summer infestations of the European red mite, and excellent control can be expected from sprays containing as little as 12 ounces in 100 gallons.

**Control of Cabbage Maggot.** (W. D. Whitcomb, Waltham.) The natural field infestation of cabbage maggot at Waltham was heavy and caused commercial injury to 88 to 90 percent of the untreated plants of susceptible varieties such as Golden Acre and Copenhagen Market.

The first eggs were found on May 1 which is about the average date for the last 12 years.

A study of the relative susceptibility of 13 varieties showed 4 early varieties and 3 medium or late varieties with more than half of the plants severely injured or killed and more than 80 percent commercially injured, while 2 early varieties and 4 medium or late varieties had less than half the plants severely injured or

killed and less than 80 percent commercially injured. The most severely injured varieties were Copenhagen Market and Super-curved Savoy; Early Jersey Wakefield showed the least injury.

Tests to determine the possibility of reducing the amounts of corrosive sublimate or calomel in treatments for combating the cabbage maggot during the war emergency showed that two applications of corrosive sublimate at 1 ounce in 15 gallons of water (1-1920) was equal to or more effective than two applications of this material at 1 ounce in 10 gallons of water (1-1280) which is the normally recommended concentration. Calomel-talc dust containing 2 percent calomel was very nearly as effective as the dust containing 4 percent calomel (the normal recommendation) when applied by the mound method; but was significantly inferior to the 4 percent dust when applied twice with a hand duster.

**Control of Squash Vine Borer.** (W. D. Whitcomb, Waltham.) As in previous experiments, spraying with 1 percent Volck plus nicotine sulfate 1-500 was the most effective treatment.

A rotenone-copper oxychloride sulfate dust containing .75 percent rotenone was also effective and distinctly more satisfactory than a pyrethrum-yellow cuprous oxide dust containing 3 percent of a petroleum solution of pyrethrins.

A DNOCHP-gypsum compound containing 20 percent of the toxicant reduced the borer infestation nearly two thirds but produced only slightly more mature squash than the check. Vines treated with a calcium arsenate-copper oxychloride dust (5.25 percent tricalcium arsenate) were more heavily infested with borers than the untreated vines but produced the largest yield in the experiment, indicating that a light borer infestation, especially after secondary roots have developed, does not seriously reduce the yield of mature squash.

**Control of Striped Cucumber Beetle.** (W. D. Whitcomb, Waltham.) With the existing light infestation which produced only about one tenth as many beetles as in 1941, a calcium arsenate-copper oxychloride dust (5.25 percent tricalcium arsenate) gave 90 percent protection to cucumbers and complete protection to melons, which is very encouraging in view of restricted use of rotenone during the war emergency. Rotenone-copper oxychloride sulfate dusts containing .75 percent and .5 percent rotenone respectively were about equally effective, the former giving slightly better protection on the cucumbers and the latter on the melons. It is evident that the dust containing .5 percent rotenone will be satisfactory if available. A pyrethrum-yellow cuprous oxide dust containing 3 percent of a petroleum solution of pyrethrins was less effective than the rotenone dusts but generally satisfactory. On the other hand the same pyrethrum dust without yellow cuprous oxide gave only about 50 percent protection, although the yield of melons following the treatment was the greatest in the experiments, apparently because of a partial control of aphids and other sucking insects which spread mosaic.

**Control of Onion Thrips.** (A. I. Bourne.) In field tests with insecticides the standard combination of nicotine sulfate and soap again proved superior to all other treatments, giving 87 percent reduction of thrips. A commercial rotenone solution proved nearly as effective and gave greater residual protection. A spray composed of castor bean extractive proved ineffective, largely because of its oily nature and poor wetting qualities. A pine oil derivative in a penetrating soap gave 74 percent control. Its effectiveness was not materially increased when derris was added. A commercial pyrethrum dust (Pyrocid) gave 70 percent control, an excellent showing for dust application and good commercial control. Fixed nicotine sprays were only moderately effective, but a nicotine tannate spray gave 74 percent effective control. A nozzle adapted to deliver a solid-cone



type of spray proved much more satisfactory and gave better penetration than the conventional hollow-cone spray.

Ladybeetles and other natural enemies of thrips did not appear in the fields in sufficient numbers to keep step with the rapid increase in thrips during late July, and there was no evidence of the presence of the fungus disease which usually appears in the fields in seasons when thrips are unusually abundant.

**The Value of Control Measures to Supplement the Standard Spray Program for Apple Pests in Massachusetts.** (A. I. Bourne.) The study of proposed substitutes to replace or supplement present standard materials and practices was shaped to give special attention to replacements for materials subject to curtailment because of the war emergency. This involved a determination of the value of certain non-arsenical compounds and a study of more effective timing of late season applications.

In a study of the effect of pyrethrum on overwintering larvae of the codling moth in their cocoons on the trees, a pyrethrum-kerosene solution was applied to the rough, flaky bark of the main trunk and base of the larger limbs of a small block of apples, early in April while the trees were still in dormant condition. These trees received no other application for codling moth control. Collections of both drops and samples from these trees showed less than one-fourth as many apples with codling moth stings and entrances on the treated trees, as on the checks. The pyrethrum-oil application caused no damage to bark nor retardation of seasonal development. It apparently had no permanent repellent action to codling moth larvae as indicated by approximately the same number of larvae collected in chemically treated bands, from both sprayed and untreated trees, at the end of the growing season.

This treatment eliminates the necessity for most of the scraping of loose bark from the trees and should prove very effective in penetrating the winter cocoons of larvae hibernating in piles of prop poles. These often attract large numbers of larvae and, since they are usually collected in piles at the edge of the orchard, serve as potential centers of infestation often entirely overlooked by the grower.

In orchard tests to determine the value of various non-arsenicals for codling moth control, one application of a fixed nicotine (14 percent nicotine) replacing lead arsenate in the 4th cover spray reduced codling moth damage to 1.5 percent as compared with 4 percent following the present standard schedule. Fruit from unsprayed checks in this block showed 19.4 percent injury by codling moth.

Where fixed nicotine replaced lead arsenate in the 4th cover spray and was also applied in mid-August, samples of fruit at harvest showed less than 6 apples per 1,000 damaged by codling moth.

A modified schedule in which a commercial pyrethrum-rotenone combination was applied in the 2d, 3d, 4th, and mid-August sprays practically eliminated codling moth damage. Lead arsenate was used with this combination but at reduced strength.

An application of fixed nicotine between the 2d and 3d cover sprays to furnish protection between June 12 and July 9 gave increased protection against codling moth, although the effect was not so pronounced as would be the case in a year when codling moth presented a more serious problem.

All of these materials were used with the wettable sulfur for scab control, proved entirely compatible with the fungicides, and held scab to less than 1 percent damage while samples from unsprayed trees showed 92 percent scabby fruit.

**Insecticides for the Control of European Corn Borer.** (A. I. Bourne.) The warm, dry weather in April stimulated corn borer activity and, as in the previous season, promoted early pupation of the overwintering larvae. Field collections



in the Connecticut Valley showed 20 to 30 percent pupation by the first week of May, and the first moths emerged on May 12. Emergence increased steadily to a peak on June 8 with a gradual reduction during the next 10 days. Coupled with the comparatively small carry-over of borers because of the light infestation in 1941, this early moth emergence, in advance of the development of the corn, resulted in a comparatively light infestation of early market sweet corn although somewhat heavier than in 1941. There was, however, a substantial build-up during the summer and a more normal infestation of the corn which matured in late August and September.

In the experimental plots the insecticidal applications, based on the first appearance of young, newly hatched larvae, were made on June 10, 15, 20, and 25. Precipitation during that period, while it totaled 2.8 inches of rainfall, was so well distributed that there was very little interference with the treatments.

Because of the war emergency and the limited supply of rotenone available, the sale of this material for use on corn was forbidden so that the field tests were confined to a study of the value of nicotine bentonite and dual-fixed nicotine.

Results from spraying with nicotine bentonite (14 percent nicotine) indicated a considerable increase in protection when 3 pounds per 100 gallons were used as compared with 2 pounds, but no advantage when more than 3 pounds were used. Protection was good in all cases. Dual-fixed nicotine dust again furnished good protection.

From the commercial standpoint the contrast between the corn harvested from treated and untreated plots was more pronounced than can be indicated by figures. Many of the ears scored as "infested" in the treated plots contained very small borers which had hatched after the last application but had scarcely penetrated the husks. A large proportion of such ears could be salvaged. Infested ears from the check plots, however, contained many large, fully developed borers; destruction of the kernels was extensive; and most of the ears were worthless.

**Potato Spraying Experiments.** (A. I. Bourne.) The experimental plots were planted May 4 and 5. The plants made an early start, received no serious setback to their steady growth during a long growing season, and were for the most part alive and green until killed by frost on September 28 to 29, 146 days from the date of planting.

Flea beetles appeared in large numbers as soon as the plants were up, were very abundant throughout June and early July, and again from late July until mid-August. There were no serious infestations of other insects.

The plots were given 11 applications of spray between June 5 and August 25. In view of the war emergency and the possible shortage of copper for agricultural purposes, special attention was devoted to a study of different strengths of bordeaux, and one plot was given a complete schedule of 2½-2½-50 bordeaux mixture to determine the protection furnished against disease and insect attack by the reduced dosage.

Flea beetle injury was measured by the number of leaf punctures per square inch of leaf area, and varied inversely with the strength of the bordeaux mixture. In every case the addition of calcium arsenate to the bordeaux mixture reduced the number of feeding punctures. The reduction was greatest (one half) in the plots which received the half-strength bordeaux, and was only slight in the plots which received the standard 5-5-50 bordeaux, indicating that the addition of the arsenical was an important factor whenever the strength of lime in the bordeaux was reduced.

Sufficient protection was furnished by all the different strengths of bordeaux to keep the plants alive and vigorous throughout the growing season, and scarcely a trace of blight was noted. In an adjoining plot which was sprayed with a com-

mercial neutral copper fungicide, the plants were badly riddled by flea beetle, began to die down in late July, and a large proportion were dead by late August. The yields in all the bordeaux-treated plots were very satisfactory.

The results in the plots treated with  $2\frac{1}{2}$ -2 $\frac{1}{2}$ -50 bordeaux were very satisfactory and encourage the hope that, during the present emergency at least, reasonable protection from disease and insect pests may be secured with a considerable saving in materials.

**Investigations on the Effect of Insecticides on Honeybees.** (A. I. Bourne and F. R. Shaw). The investigations during 1942 were conducted along two main lines:

1. The use of materials that might be added to spray or dust mixtures to repel bees. Of those used, creosote appeared to be the most effective in repelling the bees but injured apple foliage. Tests are being continued to try to find some material that will be effective as a repellent and yet be safe on plant foliage.

2. The effect on bees of materials used as ant poisons, together with an investigation of the danger of bee poisoning resulting from the use of commercial ant baits. The ant poisons tested contained either thallium sulfate or some arsenical, most commonly sodium arsenite. Because the arsenical compounds killed the bees so quickly, there was less danger of the poison being carried back to the hive than in the case of the slower acting thallium compounds.

Experiments with commercial ant traps, used as directed by the manufacturer, indicate that very slight danger to bees will result if the ant poisons are in salve boxes or similar types of containers. The use of sweetened ant baits exposed openly would appear questionable, not only from the danger to bees but also from the aspect of safety to man and other animals.

**Naphthalene and Similar Compounds as Greenhouse Fumigants.** (W. D. Whitcomb and Wm. Garland, Waltham.) Experimental fumigations using a mixture of monochlor naphthalene 3 parts and flake naphthalene 1 part were continued at various relative humidities. Satisfactory control of the common red spider mite occurred only after  $\frac{3}{4}$  ounce of the fumigant was vaporized in 1,000 cubic feet and the mites had been exposed for 3 hours. Fumigations at 50, 60, 70, and 80 percent relative humidity and 60°F. showed no significant differences as the relative humidity was increased, indicating that this factor is less important than temperature, which has shown increased mortality at the higher temperatures.

**Biology and Control of the Apple Leaf Curling Midge.** (W. D. Whitcomb, Waltham.) In emergence cages in the insectary no midge flies emerged in 1942 from maggots collected in June and July 1941, while 67 percent of the maggots collected in August transformed to flies in 1942.

Emergence of the first generation flies at Waltham was about two weeks later than in 1941 and oviposition was negligible on the trees under observation. Emergence of flies again occurred July 20-25 and August 8-15, and the greatest oviposition of the season occurred August 18-27. Larvae were collected in bands in large numbers on July 28 and on September 10, and precipitation exceeding 1 inch was recorded at each time. The influence of rain in causing the maggots to leave the rolled leaves was very noticeable.

Treatment of the soil under lightly infested trees with naphthalene flakes at the rate of 2 pounds per 100 square feet gave almost complete control of midge flies for both the first and the second generations. Spraying during the height of the oviposition period of the second generation, caused a measurable reduction in the number of infested tips where a rotenone or a DN spray was used but no reduction where a pyrethrum spray was used.

**Control of Common Red Spider Mite on Greenhouse Plants.** (W. D. Whitcomb, Wm. Garland, and Wm. E. Tomlinson, Jr., Waltham.) Studies of the pH of the sap of several of the host plants of the common red spider mite showed that the lower the pH of the plant sap the less time was required for the mite to develop from hatching to adult. These results are based on investigations with rose and carnation plants. Preliminary experiments with tomato, bean, sweet pea, snapdragon, gardenia, and chrysanthemum have been made and this phase of the work will be continued.

Among the experimental sprays for the control of the common red spider mite on greenhouse roses, a commercial mixture of gypsum and dicyclohexylamine di-dinitrocyclohexylphenate containing 20 percent of the toxicant, applied two or three times at weekly intervals, gave practically complete control when used at the rate of 24, 20, or 16 ounces per 100 gallons of water with Ultrawet 1-1000 as a wetting agent. On unsprayed plants in the same bench, the number of spiders increased 40 percent during the same interval.

A commercial spray known as technical mannitan laurate reduced the number of live mites 89 percent in four applications at 1-400, and 73 percent at 1-600. Two other rotenone materials gave fair control of the red spider mite and a third material was ineffective.

Several of these materials were more effective against the red spider mite on carnations than on roses.

**Control of Plum Curculio in Apples.** (W. D. Whitcomb, Waltham.) The effect of different amounts of spray on the control of the plum curculio in apples was studied by applying a measured quantity to apple trees of known size. An application of 1 gallon per 100 square feet was significantly more effective than an application of  $\frac{3}{4}$  gallon, but  $1\frac{1}{4}$  gallons per 100 square feet were not consistently more effective than 1 gallon, indicating that the results might be influenced by factors other than gallonage.

Cryolite, 4 pounds in 100 gallons, used as a substitute for the same amount of lead arsenate, gave somewhat less control of the plum curculio in apples, and caused very severe russet on Delicious apples.

Lead arsenate was used at the rate of 2, 3, and 4 pounds in 100 gallons of spray on Northern Spy for protection against the plum curculio. Results indicated that 4 pounds is necessary for satisfactory control where this insect is abundant.

**Biology and Control of the Grape Plume Moth.** (W. D. Whitcomb and Wm. E. Tomlinson, Jr., Waltham.) Experimental dormant applications of the commercial DN product Elgetol confirmed previous experiments which showed that a  $\frac{1}{2}$  percent dilution did not give satisfactory control under the same conditions where a 1 percent dilution was effective.

The effect of pruning in reducing infestation was studied on two vines. Heavy pruning (removing 79 percent of the nodes and canes) destroyed 72 percent of the eggs as compared with 55 percent destroyed by light pruning (removing 50 percent of the canes and nodes).

**New Vegetable Insect Pests.** (W. D. Whitcomb, Waltham.) The snout beetle, *Baris scolopacea* Germ., discovered at Arlington in 1941, was quite destructive to Swiss Chard in the vicinity of Waltham. Typical injury consisted of egg cavities and feeding punctures in the stems of the chard, making the stalks unsightly and unfit for market. Preliminary trials with applications of rotenone dust indicated that this treatment will reduce the abundance and destructiveness of this insect.

In the late summer and fall of 1942, several acres of celery, particularly in Arlington, Belmont, Waltham, and Woburn, were severely damaged or destroyed

by the plant bug, *Lygus campestris* L. Typical injury resulted from the punctures by the bugs in the heart and new stalks of the celery. The punctures were usually infected with a bacterial or fungus rot which turned the heart black, making the celery unfit for sale and often useless for any purpose. Reports from growers indicate that spraying with powdered derris and a wetting agent, prepared by the formula recommended for spraying to combat the European corn borer, is helpful and will give satisfactory control if the applications are started while the infestation is light.

**The Effects of Solar Heat on the Subcortical Development of Elm Bark Beetles.** (W. B. Becker.) In addition to laboratory and field work with *Hylurgopinus rufipes* in Amherst, field work with this species was also carried on in Pittsfield this summer. Work on *Scolytus multistriatus* was carried on in Springfield and Westfield.

Two brief tentative observations on the trend of the field work may be given now. (1) Freshly cut elm logs, not yet infested with the beetles, which were placed (in the early spring) in a north-south position where the sunlight could strike them all day, did not seem to become infested with any elm Scolytids on most of the upper half throughout the season. This applied to logs up to 4 feet 4 inches in diameter with bark up to 2 3/16 inches thick. (2) When Scolytid beetles were already in the bark before the logs were placed in the sun, the mortality due to the high subcortical temperatures generated by the sun's rays varied with the thickness of the bark, mortality being highest and including a broader arc of the upper surface in logs with thin bark. Some factors to be considered in this work are the weather, thickness of bark, and diameter of logs, as well as the effects of heat on different species of bark beetles.

**Some New Findings of *Scolytus multistriatus* Marsham in Massachusetts.** (W. B. Becker.) This species was found to be abundant at a locality in Springfield and was also found in Pittsfield. Federal scouts attached to the office of the Bureau of Entomology and Plant Quarantine at Bloomfield, New Jersey, uncovered infestations in Williamstown and North Adams.

**Insect Pests of Wood and of Shade, Forest, and Ornamental Trees in Massachusetts.** (W. B. Becker.) During the year, 249 inquiries were received about such insect pests, involving 72 species. Ants, termites, powder post beetles, aphids, oak twig pruners, Japanese beetles, and secondary tree-boring insects were received most frequently.

## DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

**Breeding Snapdragons for Varietal Improvement and Disease Resistance.** (Harold E. White, Waltham.) Two types of resistance to rust have been observed in snapdragons. The first is inherited as a simple dominant factor which has been reported previously. The second is a modified dominant type obtained from progeny of crosses made with susceptible commercial varieties. The most promising rust-resistant strains are those developed by inter-crossing susceptible commercial greenhouse forcing varieties. These strains are 80 to 100 percent resistant to rust, free flowering in winter, and good seed producers. The plants can be propagated from cuttings and such material has been highly resistant to rust for three seasons in field and greenhouse tests.



Resistance to other diseases, such as Verticillium Wilt and Powdery Mildew, has not been conclusively determined, although in some seasons a few strains have appeared somewhat less susceptible to these diseases than commercial varieties.

**Soilless Culture of Carnations.** (Harold E. White, Waltham.) The use of gravel as a cultural medium has been continued for demonstration purposes and for comparison of the responses of carnations to various nutrient formulas. Four formulas were used, which gave the following number of blooms per square foot: Ball's, 14.80; New Jersey, 15.77; Ohio 2 WP Modified, 19.33; Ohio 2 WP Modified plus  $\frac{1}{2}$  formula weights of phosphate and potash, 18.61; soil plot (checks), 17.44.

Plants grown in soil and transplanted to gravel require considerable time for adjustment and development of a root system adapted to the gravel medium. The most critical cultural period for the plants is after they are transplanted from soil to gravel. Keeping the gravel too wet soon after planting will cause heavy losses of even the most vigorous plants; and, contrary to what has been claimed, observations show that weak plants give no better results in gravel than in soil.

A commercial grower should not find it difficult to grow carnations in gravel as far as manipulation of the nutrients is concerned; but the costs of installation at present are very high and it is impossible to obtain fertilizer salts or pumps for the duration of the war.

**Cultural Requirements of Freesias.** (Harold E. White, Waltham.) Freesia corms pre-cured for 2 to 11 weeks prior to planting lost from 3 to 24 percent of their original weight—a greater loss than in the two previous years because of differences in moisture content of the 1941 crop.

Corms planted August 17 to 25 required 173 days to flower; those planted October 20, 133 days; while those planted on November 1 flowered in 123 days. Freesias bloomed earlier when grown in benches than when grown in bulb pans. Increasing the growing temperature to 60°F. in mid-November hastened the blooming of early planted corms by 3 to 4 weeks.

**Disease Resistance and Heredity of Carnations.** (Harold E. White, Waltham.) Microscopic examinations and germination tests of pollen from 25 varieties of carnations were started in September and continued through October and November. In the early September tests pollen from the four varieties, Johnson's Crimson, Olivette, Barbara Brigham, and Peter Fisher, responded satisfactorily with 60 to 70 percent germination. Subsequent tests made at weekly intervals on pollen from these same varieties yielded very poor results. Freshly collected pollen dried in a temperature of 72°F. for 1 to 3 days and other samples exposed to sunlight for 6 hours failed to germinate. Microscopic examination of pollen did not reveal any morphological peculiarities which could be associated with poor germination responses. A few imperfect or shriveled pollen grains were common to all varieties but were not numerous enough to be considered a factor in causing poor germination.

The size of pollen grains in the different varieties did not vary greatly, ranging from 45 to 49 microns in diameter. A number of giant grains similar to those characteristic of tetraploid plants were found mixed with pollen of normal size. Typical pollen characteristics were spherical shape, external markings of extine being punctate with distinct pores.

Only 5 out of 23 varieties produced seed with self-pollination. Seed production was low, varying from 10 to 21 seeds per capsule. On the basis of observations made on germination and fertilization, it would seem that the ability of pollen to germinate is influenced by environmental conditions present at the time it is formed.

**Packet Seed Studies.** (Clark L. Thayer.) The Department of Floriculture cooperated with the Seed Laboratory for the seventh season in conducting tests to determine the quality of flower seeds sold in retail seed stores, chain stores, schools, and other outlets. The seeds were tested for germination and performance under field conditions. Results are reported in Control Series Bulletin 115.

## DEPARTMENT OF HOME ECONOMICS NUTRITION

Julia O. Holmes in Charge

**Vitamin Requirements of Older People.** (A. W. Wertz.) The urinary thiamin excretion of three elderly women was followed for a period of 14 weeks. The diet was supplemented with 3 mg. of thiamin chloride for the first half of the period and then with 1 mg. thiamin plus enough yeast to bring the total thiamin to 3 mg. The excretion of thiamin in the urine was almost twice as much in the latter period as in the first period, although the intake of thiamin was identical. This might indicate that there is some factor supplied by the yeast which has a definite effect on thiamin utilization in the body. There was no change in the electrocardiograms from the first period. The hemoglobin values decreased.

**The Effect of Temperature on Calcium Metabolism in Growing Rats.** (Marie S. Gutowska.) One series of experiments was conducted at temperatures below 57° and above 90°F. (approximately the limits beyond which the albino rat will not breed satisfactorily); and another series at 73° and 83° (corresponding to the normal range of breeding temperatures). In both series the calcium retention was greater in the low-temperature group, whether determined by balance experiments or by carcass analysis. Growth was slower at the low temperatures. Food consumption was considerably larger in the groups of slow-growing rats kept at the lower temperatures, but food utilization was noticeably lower than in the groups kept at the higher temperatures. It was concluded that temperature plays a much greater role in practical nutrition than is now realized.

It is hoped that these findings, if confirmed by tests on adult rats now in progress, may have some bearing on the food requirements of humans as influenced by varying ranges in temperature.

**The Effect of Temperature on the Cure of Rickets.** (Marie S. Gutowska.) Two groups of six rats each were depleted of their vitamin D and placed in closed cabinets, one group at 66°F., the other at 82°. All received in three days 4 U.S.P. units of vitamin D. Two rats from each group were killed on the fourth, sixth, and eighth day from the beginning of the assay period. It was apparent, both from photographs and from line tests, that the rats kept at the lower temperature showed an earlier response to the treatment and an earlier healing of the rachitic sections than the rats kept at the higher temperature. It was concluded that the biological materials and the temperature at which the bioassay is conducted must be standardized in order to reduce the errors of the test; and that by lowering the temperature, it may be possible to shorten the time of the assay.

**Manganese Balance Experiments with Birds.** (Marie S. Gutowska with the cooperation of J. W. Kuzmeski of the Feed Control Service.) Manganese metabolism studies were conducted in two series of experiments. The first series was conducted with two groups of laying hens fed for a period of three months on rations varying only in manganese content (76 p.p.m. and 21 p.p.m.). The droppings were collected every three hours during a period of a week and five periods of a week each formed the series. The second series consisted of the same number

of experiments but was conducted with single hens, not with groups. The rations and the droppings were analyzed and the balance of manganese calculated.

One hen on the low-manganese ration retained approximately one half of the total available manganese daily. This suggests that even 21 p.p.m. manganese in the ration was sufficient not only to keep the hen in a positive manganese balance but also to provide a surplus so that it was not necessary to store all the amount available. The hens fed for some months on the high-manganese ration did not store any manganese, and the daily output was almost exactly the total amount of the daily intake. This means that the hens were in a complete manganese balance and that the whole surplus of manganese added to this ration was voided by the hens.

**Manganese and Reproduction of Birds .** (Marie S. Gutowska.) Three series of experiments were conducted to observe the effects of different manganese intakes by poultry on reproduction. In the first series, there was no significant difference in the fertility and hatchability of eggs from hens fed at the low (17 p.p.m.) and the high (61 p.p.m.) manganese rations. In the second series, it was found that the hatchability and fertility of the eggs dropped significantly when the birds were fed a ration containing 14 p.p.m. of manganese; but the differences were not significant in the groups fed the rations containing 17 p.p.m. and 61 p.p.m. of manganese, and the hatchability of eggs in these groups was normal.

It was concluded that 14 p.p.m. of manganese in a laying ration is a sub-minimum quantity which affects reproduction unfavorably; but 17 p.p.m. is probably not far from the threshold value needed, and 61 p.p.m. is ample. Because normal commercial rations usually contain over 40 p.p.m. of manganese, they do not need, in most cases, to be supplemented with this element.

In a third series, there was a highly significant increase in the volume of sperm produced by cocks fed the high-manganese ration as compared with cocks fed the low-manganese ration. The sperm count varied considerably in the two groups of cocks and also in individual cocks on different days. However, no significant difference between the sperm count of the two groups was found. Consequently the increase in the volume of the semen in the group was due not to a change in the density of the sperm but to improved functioning of the testes.

**Effect of Dietary Manganese on the Mineral Content of Some Organs of the Hens.** (Marie S. Gutowska and Lewis L. Glow of the Chemistry Department cooperating.) An investigation was conducted to determine whether the manganese content of the diet would influence the mineral contents of the bones, the livers and the kidneys of the hens. One group received a high-manganese ration (61 p.p.m.); the other, a low-manganese ration (17 p.p.m.).

The ability of individual hens to store or retain minerals in their bones, liver, and kidneys varied considerably; therefore large groups of birds are needed in this kind of experiment. The ash content of the bones varied more between individuals of the same group than between the averages of the two groups.

However, the hens on the high-manganese diet had a larger amount of manganese in their bones and in their livers than did the hens of the low-manganese diet; but there was no evidence that manganese could be stored in the kidneys.

The calcium and phosphorus content of the ash of the tibias and sternums of the hens was almost the same for the two groups.

It was concluded that differences in the manganese content of the diet do not influence the calcium and phosphorus content of the bones and the liver but do influence the amount of manganese in these organs. The amounts of manganese found in the bones and livers, after twelve months on a ration lower in manganese than the average commercial ration for laying hens were considered subnormal.



## DEPARTMENT OF HORTICULTURAL MANUFACTURES

F. P. Griffiths in Charge

**Cranberry Research.** (W. B. Esselen, Jr., R. S. Lubitz, C. R. Fellers, and H. J. Brunell.) Cranberry juice was found to have a definite bactericidal action on the oral flora and on pathogenic bacteria frequently associated with gastro-intestinal disturbances in man. This observed action appears to be due primarily to the high acidity of the cranberry.

By means of chemical and microbiological assays, the amounts of several of the vitamins of the "B-complex" present in 100 grams of fresh cranberries were found to be thiamin (vitamin B<sub>1</sub>), 4.5 international units; riboflavin (vitamin B<sub>2</sub>), 3 micrograms; nicotinic acid (niacin), 33 micrograms; pantothenic acid, 25 micrograms; pyridoxin, 10 micrograms; and biotin, a trace. There was little or no loss of the "B-complex" vitamins in making cranberry sauce and since the cranberries in whole cranberry sauce make up about 40 percent of the total weight of the finished product, the amount of the above vitamins present in the whole sauce was approximately 40 percent of the figures given for fresh cranberries.

Cranberries were found to contain approximately 10 micrograms of vitamin K per 100 grams, by the chick test.

**Domestic Refrigeration.** (J. E. W. McConnell and C. R. Fellers.) In household refrigerators left-over vegetables kept better and retained more of their vitamin C when stored in covered containers. The most rapid loss of vitamin C occurred during the first day of storage.

Storage of frozen foods for one day in the freezing compartment of the domestic refrigerator was found to be satisfactory. For storage periods of a week, a temperature of 16 F. was necessary to prevent excessive loss of vitamin C. A marked loss of this vitamin occurred at storage temperatures of 20° to 32°.

Either defrosting of frozen foods at a high temperature or slow defrosting at low temperatures resulted in a considerable loss of vitamin C.

**The Nutritive Value of Mushrooms.** (C. R. Fellers, E. E. Anderson, and A. S. Levine.) Work conducted during the past year shows that fresh and canned mushrooms (*Agaricus campestris*) surpass many of our staple fruits and vegetables in nutritive value. The mineral or ash content of mushrooms is high, particularly in iron. Mushrooms have been found to be one of the best plant sources of thiamin, riboflavin, pantothenic acid, and nicotinic acid. They also contain significant amounts of ascorbic acid and vitamin K.

**Red Squill Research.** (A. S. Levine, C. R. Fellers, and L. R. Parkinson.) Work on the toxicity of red squill (a raticide) was continued, and a standardized assay method has been developed.

**Preservative Values of Organic Acids.** (A. S. Levine, M. G. O'Connor, and C. R. Fellers.) The bactericidal value of benzoic acid is somewhat greater than that of several of its salts. Magnesium and ammonium benzoate compared favorably with sodium benzoate in inhibitory properties. Calcium benzoate was the least toxic of the several compounds tested. It is assumed that the undissociated benzoic acid molecule is the active germicidal agent that represses yeast growth.

Sodium chloride and ethyl alcohol in apple juices which were treated with sodium benzoate markedly inhibited the growth of yeasts. The presence of 30 percent dextrose in apple juice caused some inhibition of yeast growth, its inhibitory power being greater than that of sucrose under these conditions.



**Glass Container Research.** (W. B. Esselen, Jr., E. L. Moore, J. J. Powers, and C. R. Fellers.) As previously reported it has been found that ascorbic acids function effectively as antioxidants for glass-packed foods. Only that amount of ascorbic acid needed to react with oxygen present within the sealed container is beneficial as far as color and flavor changes are concerned.

The results to date indicate that the addition of ascorbic acid to fruits and vegetables naturally low in vitamin C protected them from discoloration and flavor changes. Ascorbic acid functioned successfully as an antioxidant for peaches, pears, plums, and carrots; was only moderately successful with apple-sauce and beets; and had no effect on such products as snap beans and peas, known to be moderate to good sources of vitamin C.

It was found that oxygen and the decomposition of ascorbic acid are the principal factors involved in the darkening of packaged orange juice. The darkening is accelerated by warm storage temperatures, but rate and intensity of darkening were significantly affected by exposure to intense light.

Deleterious flavor changes in canned and bottled orange juice occur very soon after the juice is packed, and are associated with the methods used in the preparation of the juice rather than with the type of container or the vitamin C content of the juice.

Tests conducted with glass-packed fruits and vegetables stored at room temperature for one year showed that, under average commercial conditions, there is no danger that light will cause the color to fade.

**The Antioxidant Properties of D-Iso Ascorbic Acid.** (F. J. Yourga, W. B. Esselen, Jr., and C. R. Fellers.) Preliminary feeding tests indicate that d-iso ascorbic acid has an antiscorbutic potency about 1/25 that of l-ascorbic acid (vitamin C).

Evidence has been obtained which indicates that d-iso ascorbic acid may be used as an antioxidant to prevent or retard the oxidation of l-ascorbic acid in packaged foods.

**Fruit Jellies and Jams.** (A. S. Levine, S. G. Davis, W. H. Fitzpatrick, and C. R. Fellers.) The beach plum (*Prunus maritima*) is characterized by a distinctive astringent flavor. It is relatively high in ash and carbohydrates and slightly low in pectin as compared with some other varieties of plums. A number of highly desirable products can be made from this fruit, among which jam, jelly, and butter are the most popular. Generally the fruit is deficient in pectin for jelly purposes, and addition of pectin was found necessary for the production of a high-grade jelly. No added pectin was necessary for the jam or butter.

The substitution of pectin and corn sugar for cane sugar has been found feasible in jelly making. While the jelly is of fair quality, it is somewhat higher in cost and lacking in flavor when compared with jelly made with all cane sugar.

**Apple Products.** (A. S. Levine, F. P. Griffiths, S. G. Davis, C. R. Fellers, J. J. Powers, and W. B. Esselen, Jr.) A cider apple jelly of highly desirable taste, flavor, and color was prepared by adding sweet Baldwin cider, concentrated to one-third its original volume, to the heat-extracted apple juice from an equivalent weight of apples. The amount of dry sugar added was about 60 percent of the apple stock used. The remainder of the sugar was naturally present in the added cider. The mixture of concentrated cider, extracted apple juice, and sugar was concentrated by boiling to a soluble solids content of 68 percent by the usual jelly manufacture procedure. Cider apple jelly is a distinctive product of attractive color and appealing flavor, superior in quality to either apple jelly or cider jelly alone.

Work has been done on the farm and home production of apple syrup to replace sugar and corn syrups. Partial neutralization of the acid in fresh apple cider with baking soda and concentration of the cider approximately seven to one produces a sweet, pleasant-tasting syrup which can be used on the table or for making apple sauce, apple butter, mince meat, or other products. As most fresh apple ciders contain between 10 and 13 percent of sugar it only requires between six and seven quarts of cider to produce one quart of syrup. Clarification of the syrup can be obtained by proper use of gelatine but for most home uses it is not considered necessary. Many New England farms having cull apples, a cider press, and a maple sugar evaporator are in a position to make large quantities of this syrup.

**Marine Products Research.** (C. R. Fellers and R. G. Tischer.) A successful method for canning the blue crab (*Callinectes sapidus*) which is common along the Central and Southern East Coast of this country has been developed in this laboratory. A preliminary investigation has been made to find out whether this method is equally satisfactory for the canning of the sand crab (*Platyonichus ocellatus* Latreille), an edible crustacean which abounds in coastal waters from New York to Nova Scotia. The aluminum dip method for preventing discoloration of canned crab meat was found to provide a satisfactory procedure for the packing of sand crab meat in both glass and metal containers.

**The Effect of Processing on the Available Iron in Foods.** (F. R. Theriault and C. R. Fellers.) The dipyriddy method for available iron gave consistent results for fruits, vegetables, and fish and checked with the bioassay method.

The commercial quick freezing of foods was found to increase the availability of iron slightly. Canning in glass had little or no effect on total and available iron.

Foods canned in tin showed changes in iron content somewhat correlated with their hydrogen ion concentrations. No change or slight gains in iron content were observed with vegetables, and considerable gains in iron occurred in the case of the more acid fruits. Fish (red perch), with a pH value of 6.9, lost half of its total iron and nearly all of its available iron when packed in tin cans lined with zinc enamel (C-enamel). With semi-acid and acid foods the iron gained from the can was nearly 100 percent available.

**The Development and Control of Molds in Vanilla Beans.** (F. W. Wenzel, Jr., A. S. Levine, and C. R. Fellers.) Vanilla beans which have been properly cured and aged are resistant to molds because of the presence in the beans of natural compounds, such as vanillin, which possess mycostatic properties. Improperly cured beans are susceptible to the growth of the saprophytic *Aspergilli* and *Penicillia*. Moisture and humidity regulation, refrigeration, and storage of the beans in carbon dioxide may be utilized as means of partial mold control. Ultraviolet irradiation of the beans is of little value as a control measure. Prevention of mold growth may be secured by immersion of the beans in an alcoholic vanillin solution or by vacuum fumigation with ethylene oxide.

**The Use of Levulinic Acid as a Food Acidulent.** (C. R. Fellers, R. G. Tischer, and B. J. Doyle.) The present shortage of the acids commonly used in foods has created a need for adequate substitutes. Levulinic acid (B-acetylpropionic acid) may now be prepared from corn at a fairly low price. Laboratory and clinical tests have shown that levulinic acid, even in excess of amounts that might be commonly used, is non-toxic to humans, rats, guinea pigs, and chickens, and suggest that levulinic acid in small amounts may be safely used to acidulate foods or beverages.

Jellies and carbonated beverages were successfully prepared using levulinic acid. Tests in bread and other bakery products indicate that levulinic acid is at best only weakly mycostatic.

**Dextrose Investigations.** (W. B. Esselen, Jr., H. Fram, and A. S. Levine.) It was found that sucrose and dextrose had similar effects on the thermal resistance of microorganisms commonly associated with the spoilage of acid food products.

## DEPARTMENT OF HORTICULTURE

R. A. Van Meter in Charge

**Nurseryculture.** (C. J. Gilgut.) In the commercial culture of ornamental plants interest has been confined almost entirely to the production of esthetic effects. During the early stages in the development of a research program with plants in this class, it was necessary to devote much attention to the study of their habits to learn their response to cultural practices. While the results may not have contributed anything sufficiently conclusive to justify recommendations for use in commercial production, they have unquestionably prepared the way for the development of a sound research program which is gradually being formulated.

## DEPARTMENT OF OLERICULTURE

G. B. Snyder in Charge

**Variety Studies.** (W. H. Lachman and G. B. Snyder.) The 1942 season was very favorable to the growing of vegetables and furnished excellent opportunity for testing some of the newer strains. Tomatoes, cucumbers, sweet corn, Pascal celery, and beans were given special consideration. While nothing significantly conclusive resulted from these tests, information has been gained concerning habits and cultural response that will serve in evaluating the merits of the several varieties and strains included in this study.

**Asparagus Investigations.** (Robert E. Young, Waltham.) In the asparagus breeding plots, yields from selected strains were 60 percent higher than last year. The increase in production was quite uniform for all strains, even though the best produced just twice as much asparagus per plant as the poorest. This poorest strain was commercial Mary Washington, indicating that with the proper selection of parent material the yield can be greatly increased. The order of yield of these strains has followed fairly closely the average yield of the parent plants.

Although the yield was so much higher, the average size of spear showed only slight increase, and this did not seem to be correlated with yield or size of spear in previous years.

A division of the spears, during harvest, into four different sizes showed that the percentage of both small and large spears has remained quite constant for all strains for all years and that the change has been a decrease in the medium size and an increase in the very large. The percentage of very large spears varied from 53 percent for the highest yielding strain to 25 percent for the lowest yielding; so the best strain from the standpoint of yield was the best from the standpoint of quality also.

Rust varies with seasonal conditions, but some selected strains showed only 52 percent infection as compared with 83 percent for the commercial strain. Rust of sufficient severity to cause any injury to the plant occurred on only a fourth of the total population. This compared with 14 percent on the old asparagus plants growing alongside, from which the strains under comparison were derived; and 67 percent for a row of the Paradise variety, known to be more susceptible to rust.

**Vegetable Breeding for Improvement of Quality.** (Robert E. Young, Waltham.) During the year breeding and general varietal studies were conducted with a number of the common vegetables including tomato, Summer Pascal celery, lettuce, rutabaga, beet, greenhouse cucumber, broccoli, and carrot. While there has been an extensive accumulation of information concerning the possibilities and habits of these several vegetables, the results are not sufficiently conclusive to justify detailed discussion, except in a few cases.

**Trellis Tomato.** The breeding program to improve the internal quality of the two strains of trellis tomatoes developed here was continued with a very satisfactory crop. Since most of the tomatoes that have better internal quality are later maturing, some of the desirable  $F_2$  population has been back-crossed to Trellis No. 22 to get earlier yield. A small early tomato, Denmark, has also been used for some of the back crosses. Some new hybrids were made in the greenhouse and planted for the summer crop, to determine what varieties could be combined with Trellis No. 22 to take advantage of the hybrid vigor.

The most productive hybrid tried this year was Trellis No. 22  $\times$  Maine No. 85. This produced an early yield 44 percent greater than Trellis No. 22, with an 11 percent greater total yield, although the percentage of No. 1 fruits was only slightly larger for the hybrid. Work with this hybrid will be continued. There were other first-generation hybrids that produced an increase in yield, and the second generation hybrids were above average in early yield.

**Greenhouse Tomatoes.** The spring crop of tomatoes was used as a test crop in the use of a hormone spray to produce fruit without seed. Every other plant was treated by spraying the cluster about the time two to three blossoms had opened. Three applications were made one week apart, and some of the buds on the second cluster were small at the time of the last spray. The use of the hormone spray almost doubled the average set of fruit on the first cluster. The spray did not make so much difference in the set of the second cluster — 52 percent for the sprayed, compared with 39 percent for the unsprayed. For both clusters, the three sprays produced a set of 64 percent compared with 38 percent for the untreated plants. There was no noticeable difference in flavor between the seedless fruit and that having seed.

The disadvantage of this spray is that it must be confined to the flower cluster because it affects the foliage about the same as severe mosaic. The labor of putting on the spray, where it has to be applied several times, is considerable; and further trials are necessary before its practical value can be determined.

**Rutabaga or Cape Turnip.** As reported last year, three distinct types of Rutabaga have been developed and were ready for trial, and six lots of these three types were distributed in Bristol and Barnstable counties.

No. 1 has typical Cape turnip foliage and root shape. The chief distinguishing feature is the absence of green coloring matter in the exposed shoulder, which, however, develops a purple color when exposed to the sun. When grown with sufficient foliage to furnish shade, the shoulder as well as the bottom of the root is white.

No. 2 is a uniform type having white flesh and a green shoulder, and in general resembles the White Cape strains.



No. 3 has yellow flesh and green shoulder and is, in its general characteristics, like the White Cape. Its smooth green shoulder is quite different from that of the usual yellow type.

Careful observation and study led to the conclusion that Nos. 1 and 3 were deserving of consideration for general distribution in the turnip-growing sections of the State.

*Hutchinson Carrot.* A crop of seed of the hybrid carrots which have been under development was produced in the greenhouse. This hybrid strain, compared with the regular Hutchinson in the fall crop, showed better interior and exterior color with good length and shape. On account of slower growth, however, it is not so well adapted for the early market, and attempts to improve it by breeding and selection are being continued.

## DEPARTMENT OF POMOLOGY

R. A. Van Meter in Charge

**The Influence of Various Clonal Rootstocks on Apple Varieties.** (J. K. Shaw and L. Southwick.) The stock bed set in the spring of 1940 yielded in the spring of 1942 at the rate of from about 6000 to over 20,000 rooted layers per acre. The 18 clonal types may be classified as follows:

Low yields: II, IX, X, XII, XV, A, C, Spy 227.

Medium yields: I, III, VII, VIII, F.

High yields: IV, V, XIII, XVI, Vt. 323.

This classification represents, in general, about what may be expected from these stocks, but owing to the small areas involved, there may be some that are wrongly classified. Probably Malling VIII will usually fall in the low yielding class and II in the medium class.

Many of the individual plants have died following this cutting in the second year. The number of these failures seems to differ with the different stocks. Perhaps a stock bed should be allowed to grow at least two years before severe cutting, so that larger, more vigorous root systems may be established.

The trees in our own six-year-old clonal stock orchard continue to grow vigorously and some trees have borne fair crops for their size. Thus far, there are no significant differences in the increase in trunk diameter due to stock influence. This is probably not true in all the cooperative orchards, for soil and other environmental influences are important factors in the interrelation of stock and scion.

**Lethal Incompatibilities between Clonal Stocks and Varieties of Apples.** (J. K. Shaw and L. Southwick.) The clonal stock Spy 227 was budded in 1941 to Stayman, Winesap, and two strains of McIntosh. In 1942 nearly all buds started to grow, but Stayman failed to develop and by midsummer most of the trees were dead or dying. Winesap failed a little later. One of the McIntosh strains grew normally all summer and the trees are now good one-year trees, while the other strain behaved like Stayman. Several strains of McIntosh and several varieties belonging to the "Winesap group" were budded on this stock in 1942 to see whether these varieties will act in the same way and how extensive this type of relation may be.

There seem to be lethal combinations between certain flowering crabs and certain Malling stocks. Bechtel crab failed to grow on Malling III. These combinations are being studied further.

**Tree Characters of Fruit Varieties.** (J. K. Shaw, A. P. French, O. C. Roberts, and L. Southwick.) The usual examination of commercial nurseries for trueness to name was made in the summer of 1942. While occasional new mixtures were found in inspected nurseries, the number of misnamed trees was small compared with earlier years. As the work was extended mixtures were found in cherries, pears, and plums. Increased attention is being given to peaches and thousands of misnamed peach varieties are being eliminated although it is not possible to give this as complete a service as other tree fruits. The only way to be sure that peach varieties are invariably true to name is by the maintenance of a scion orchard, known to be correctly named, as a source of renewal of budding stock.

**Comparison of Cultivation and Sod in a Bearing Orchard.** (J. K. Shaw.) Of the cultivated plots, one is now under the mulching system and is reported under the following project. Another which had no fertilizer from 1921 to 1927, but has since received nitrate of soda at the rate of 300 pounds per acre, has developed symptoms of both potash and magnesium deficiency. If potash is applied to correct this deficiency a magnesium deficiency will appear on soils not well supplied with this element. Where nitrate of soda alone is used over a period of years a potash deficiency appears on our soils under cultivation after about 10 to 15 years.

One of the sod plots of 10 trees which had been fertilized with nitrogen alone has received a N-P-K fertilizer and another similar plot a N-K fertilizer for the past four years. These plots now show a difference in yield, with the N-K plot yielding best. Both plots have increased yields over the period when nitrogen alone was applied thus dispelling, at least to this extent, the general contention that only nitrogen was necessary as an orchard fertilizer.

**Comparison of Cultivation and Heavy Mulching of Apples.** (J. K. Shaw.) The plot of nine Wealthy trees which had been mulched for 20 years continues to show superiority over the similar adjoining plot which has been under cultivation and cover crop, although no additional mulch has been applied for the past four years. There is still a thick layer of decaying mulch through which grasses, mostly quack grass, grow luxuriantly. General observations suggest that when a young orchard is planted immediately following the removal of old trees, much attention should be given to building up the soil which has been exhausted of organic matter and nutrients, because it is conceivable that old trees may be able to maintain themselves quite well on a soil so deficient that newly planted trees are unable to establish themselves and special fertilization should be provided.

The two plots in the 14-year-old McIntosh clonal stock orchard near by were mulched as last year and the yield was significantly greater than that of adjacent trees in a Ladino clover sod. No fertilizer has been applied since mulching began; while the trees in the clover have received moderate applications of nitrogen and potash. The foliage on the mulched plots was of a deeper green color and persisted longer in the fall than on the adjacent trees. No signs of a nitrogen depression have appeared on these mulched plots following the application of liberal amounts of higher carbohydrate material.

**The Effect of Orchard Mulches on the Plant Nutrients in the Soil.** (J. K. Shaw in cooperation with the Chemistry Department.) This project was continued by a second application of hay mulch under the mulched trees and collecting soil samples for analysis as last year. Grass growing up through the mulch of glass wool was suppressed. No differences in the behavior of the trees was observed. The objective is the study of the behavior of nutrients in the soil. Further comments may be found among the Chemistry projects.

### Studies of Varieties of Fruits. (J. K. Shaw and Staff.)

*Apples.* Anoka has fruited for several years. It is not equal to Duchess for commercial purposes, and its only value for us is its tendency to fruit very early in its life.

Close is an early apple, first sent out as U.S.D.A. 57. It is fairly promising as a red early apple of Yellow Transparent season, but variable in size and shape.

Webster is a large red apple originated at the New York Experiment Station. It is attractive in size, shape, and color and begins to bear early but is suitable for cooking only.

Van Buren is reported to be a bud sport of Duchess. It is remarkable in that nursery trees can be distinguished from Duchess. We know of no other bud sport in propagation that can be so distinguished from the parent variety. It is promising to replace Duchess if one wants better color.

*Pears.* Two Bartlett-like pears, Berger and Conference, have come into bearing. Berger seems to be the more promising, but it remains to be seen whether it can compete with the well-established Bartlett. Conference seemed not equal to Bartlett.

*Peaches.* N. J. 105. Large, yellow-fleshed, attractive, freestone, flesh fine to firm, should be good shipper, quality good but not outstanding, will bear watching. Ripe August 20.

N. J. 102. Large, attractive, yellow-fleshed, freestone, excellent quality, fine-textured firm flesh, ripens a few days ahead of N. J. 105. Looks very promising.

Red Rose. Flavor tart and slightly astringent even when ripe, disappointing.

*Blueberries.* GN-87. A small crop was produced on a budded bush. The berries were very large, firm, short-stemmed, oblate, very good blue, very attractive, and very good flavor. The clusters were large and compact making picking a little hard. Skins tore some during picking. Season late medium to late. Had some mummy berry. Looks very promising.

Scammell. This variety performed much better than ever before. It yielded more and larger berries, and berry size held up better during the season. Nevertheless, the yield is still too light for it to compete with commercially recommended varieties.

*Raspberries.* Tahoma is a bright red berry, not firm and of poor quality. So far it does not seem promising for Massachusetts.

Washington is a large, firm berry of good quality. Worthy of further testing.

Mercy continues to promise well. It seems superior to Taylor, and may prove worthy of cultivation here.

**Nature of Winter Hardiness in the Raspberry.** (R. A. Van Meter and A. P. French.) A plantation of 22 raspberry varieties was set in the spring of 1942, including the hardiest varieties and those most susceptible to injury by cold. Preliminary trials of canes from older plantations suggest that the buds of varieties most often injured by low temperatures have very short rest periods.

**Storage of Apples in Modified Atmospheres.** (L. Southwick and O. C. Roberts, in cooperation with the Department of Engineering.) On account of mechanical difficulties with the storage room the test could not be started until November 27. The oxygen percentage steadily decreased, reaching 2 percent in three weeks, and thereafter the room atmosphere was maintained at 1 to 2.5 percent oxygen and around 8 percent carbon dioxide by periodical "washing" out of the latter and by infrequent partial ventilation to allow oxygen build-up. There is danger of anaerobic respiration, development of off-flavors, and death of apples under long-continued oxygen levels below 1 percent. The room was opened on March 17 and the apples removed.

Cortland had scalded slightly to severely even when wrapped in oiled paper, indicating that modified atmosphere storage is entirely unsuited to this variety. The Golden Delicious were in excellent condition with practically no shriveling, indicating that for this variety this type of storage may be especially suitable. The relative humidity remained high throughout the storage period and this is particularly important in successful storage of Golden Delicious. The McIntosh were variable, with condition good but quality only fair. They were already mature to slightly over-mature when the storage began to function properly late in December and, under these conditions, they came through better than expected.

On September 25, 1942, the room was again filled and at the time of writing (November 20) the storage appears to be functioning properly.

**Nutrition of the High-bush Blueberry, Especially in Relation to Soil Reaction.** (J. S. Bailey.) A mixture of equal parts by weight of sulfur and ferrous sulfate was found to be a good remedy for iron chlorosis. The amount required depends on the acidity and buffering action of the soil and condition of the plant.

**Blueberry Culture.** (J. S. Bailey.) Buds set in 1941 gave a small percentage of successes. Winter protection of the buds by sawdust was of little value because the buds failed to "take" before the sawdust was applied. Bushes were budded in 1942 at weekly intervals from July 25 to September 3 to observe the effect of time of budding. Although some buds have already died, the "take" seems to be much better than last year.

Four new varieties, Atlantic, Burlington, Weymouth, and No. 73, have recently been added to the collection, which includes all the improved varieties now in cultivation.

**Preharvest Dropping of Apples.** (L. Southwick.) Drop-control sprays and dusts were used on McIntosh, Duchess, and Wealthy.

With Duchess, which responded markedly to drop-control sprays in 1940, the results with dusts were disappointing although the three dusts used were partially effective. Two commercial materials applied as sprays were almost equally effective and significantly more effective than the dusts.

With Wealthy, which responded poorly to "hormone" sprays in 1940, dusts were relatively ineffective as was also one standard spray. With the other spray applications, the degree to which drop was controlled was correlated with the concentration of active chemical. These results support the conclusion reached previously that under Massachusetts conditions the stronger sprays are likely to be more effective. The added cost of more concentrated sprays may or may not prove profitable.

With McIntosh, results were variable, but in general dusts were more satisfactory than with Duchess or Wealthy. The three commercial dusts varied somewhat in apparent effectiveness but more than one season's tests are necessary to confirm that differential results are really due to "brand." Repeat



applications (four days after the initial applications) increased effectiveness and, in these cases, drop-control was substantially equal to that obtained with sprays. Applications followed in a few hours by rain were less effective. This was also true in the case of a spray which failed to dry before the onset of rain. In one instance, a second application four days after the first not only increased effectiveness but prolonged the duration of effect.

From these tests, it is evident that spray applications were, in general, more effective than dusts although the differences were not so significant but what they may be easily overcome when dust applications become more perfected. For best control of drop in Massachusetts orchards it may be necessary to increase concentrations somewhat.

**Beach Plum Culture.** (J. S. Bailey.) To gain a preliminary basis for procedure and to become more familiar with this fruit and its possibilities, a fertilizer experiment was started at East Sandwich in cooperation with Mr. William Foster and Dr. C. E. Cross.

A spraying experiment was also conducted consistent with the spray program outlined by Mr. Bertram Tomlinson in Special Circular No. 46. This program gave very poor control of plum gouger, the worst insect pest of the beach plum, but eliminated completely a gall maker which was present in great numbers on the leaves of unsprayed bushes adjacent to the sprayed plot.

Plum Pockets is one of the worst diseases of the beach plum. Plenty of infected fruits were found on older bushes surrounding the sprayed plot, but none on the sprayed plot. Brown Rot, another serious disease of the beach plum, and blights were fairly well controlled.

In cooperation with Dr. H. J. Franklin and Dr. C. E. Cross, a planting of improved selections was made at the Cranberry Station at East Wareham. These selections were supplied by Mr. J. M. Batchelor, plant explorer of the Soil Conservation Service, and are considered, by him, to be the best beach plums to be found anywhere along the east coast.

Other phases of the work are reported by the Departments of Botany and Horticultural Manufactures.

**Ethylene Dichloride Emulsion.** (J. S. Bailey.) Experiments to test ethylene dichloride emulsion for the control of peach tree borers were started in the fall of 1940 and continued through 1941 and 1942. Three cases of injury to trees were observed, all of which resulted from over-dosage or faulty application. No injury has been observed where applications were properly made.

Applications made September, October 1, and October 15, 1941, were very effective in controlling peach tree borers. Those made November 1 and November 15, 1941, were not so effective.

**The Use of Peat in Planting Apple Trees.** (L. Southwick.) In the 1940 Annual Report, a progress report was made on this experiment which began in the spring of 1939. It was reported at that time that, after two growing seasons, there was no significant difference in growth between the check and the treated trees. After two more years of growth, with scanty fertilization, the same conclusion holds.

**Killing Woody Weed Plants.** (J. S. Bailey and L. Southwick.) Ammonium sulfamate at three-fourth pound per gallon of water was very effective in killing chokecherries. The black cherry is much more resistant. Sprays of this material were used at several concentrations and the speed of killing of the leaves was proportional to the concentration. It is too early to determine the effectiveness of the various concentrations in destroying the whole plant.

On July 29, 1942, poison ivy in an apple orchard was thoroughly sprayed with

ammonium sulfamate at dosages of one-fourth and one-half pounds per gallon of water. By August 1 the younger leaves were considerably browned and dried out and the older leaves showed some injury. During the following week, most of the ivy appeared to be dead. The carry-over value of the treatment remains to be determined. Experience showed that care must be exercised not to get this poison ivy eradicator on apple trees.

**Magnesium Deficiency in Massachusetts Apple Orchards.** (L. Southwick.) In September 1939, medium to severe interval leaf scorch was observed on individual McIntosh trees in two experiment station orchards. These trees also showed excessive preharvest drop of fruit. A test for potassium showed a high level of this element in the leaves from affected trees. In August 1941, the same deficiency symptoms became prevalent in these and other orchards, particularly in a young orchard set in May 1939. In 1942, the trouble was evident in many commercial orchards. Other typical symptoms besides leaf scorch included occasional yellow banding and mottling and usually abnormally early leaf fall commencing near the bases of current shoot growths and progressing upwards. The symptoms suggested magnesium deficiency and chemical analyses of leaves in the late fall of 1941 tended to support this hypothesis. At that time, soil was collected from the young orchard mentioned above and Malling rootstocks were set in 2 and 3 gallon crocks and forced into growth in the greenhouse in February. Typical deficiency symptoms became evident in all pots where magnesium was not added and the trouble was most severe in the potassium-fertilized pots. Chemical analyses of the leaves showed low amounts of magnesium wherever deficiency symptoms were prevalent and high amounts where symptoms were not present.

In August 1942, leaf samples were obtained from many apple trees. Chemical analyses of unburned leaves from trees showing variable degrees of foliage scorch and leaf fall showed that there was consistent correlation between symptom severity and the magnesium and potassium leaf contents. Magnesium was always low and potassium always tended to be high in trees showing deficiency symptoms. Most of the affected orchards were on acid soils.

Just why the trouble has been more prevalent and severe in the past two years is not easy to explain although several factors may be significant. Increased use of potassium in recent years may have caused a build-up to such a point as to accentuate the need for magnesium. Increased use of mild sulfur sprays and sulfur dusts has tended to increase soil acidity. Weather conditions, particularly rainfall, may have influenced the amounts of magnesium available to trees. These are surmises only. Of course, it is probably true that magnesium deficiency in apple orchards is not new but that it had not been recognized as such.

Magnesium deficiencies may be overcome either through the use of adequate applications of high magnesium (dolomitic) limestone or, where quicker results are desired, by applying some soluble magnesium compound such as magnesium sulfate.

**Temperature of Orchard Soils.** (J. S. Bailey.) Thermographs were placed in the soil under two McIntosh trees in the Clark Orchard, one under a mulched tree, and the other under a tree growing in sod. The following observations were made:

1. The soil temperature under mulch was lower than that under sod from March to August; from August to late January the temperature under mulch was higher; from late January to March the soil temperature under sod and mulch was about the same and nearly constant.
2. Soil under sod warmed up faster in the spring and cooled off faster in the fall.

## DEPARTMENT OF POULTRY HUSBANDRY

R. T. Parkhurst in Charge

**Broodiness in Poultry.** (F. A. Hays.) Results of crossing strains over a 10-year period confirm the hypothesis that two dominant complementary autosomal genes, A and C are necessary to produce the broody instinct in Rhode Island Red females. Extreme care in crossing strains is necessary to avoid bringing together these two genes.

The attempt is still being made to develop a non-broody strain of Rhode Island Reds through progeny testing. The major objective yet to be accomplished is to discover whether or not both genes A and C can be completely eliminated by this method.

**A Genetic Study of Rhode Island Red Color.** (F. A. Hays.) Two lines of exhibition-bred Rhode Island Reds are being developed; one selectively bred for early sexual maturity, and the other for late sexual maturity. Complete plumage color records are made on all birds, and females are trapnested for a full year to get their performance record. Feather samples are also taken at sexual maturity from all birds and these are being studied for pigment distribution.

Crosses between Rhode Island Reds and Buff Orpingtons indicate that the extension factor E for melanin pigment is not present, but that Buff Orpingtons are essentially the same as Rhode Island Reds in that the e factor permits the development of some black pigment in neck, wings, and tail. F<sub>1</sub> hybrids are intermediate in general plumage color, but the lipochrome pigment in skin, beak, and shanks is inhibited so that the color is white.

**The Effectiveness of Selective Breeding in Reducing Mortality in Rhode Island Reds.** Cooperative Project with the Regional Poultry Research Laboratory of East Lansing, Michigan, and the Department of Veterinary Science. (F. A. Hays.) Seven generations have been carried through to the age of 18 months to study the effectiveness of selective breeding in reducing mortality in one line and increasing mortality in another. The loss from cannibalism in the females of the low mortality line was double that in the high mortality line. Such losses distort the results, but there was no indication that selective breeding with small numbers is effective in reducing the mortality rate of males and females from the ordinary diseases and disorders.

Losses during this period were produced by a number of disorders but there were no acute outbreaks of disease. In many cases more than one disorder appeared in the same individual and the primary cause of death was not determined.

**Genetic Laws Governing the Inheritance of High Fecundity in Domestic Fowl.** (F. A. Hays and Ruby Sanborn.) At the present time particular attention is being given to the establishment of genetic uniformity in intensity of laying. Intensity is a complex character which has an important relation to egg size. Egg size has reached a satisfactory level, but intensity is still highly variable and there is considerable difficulty in combining large egg size with high intensity. The incidence and duration of winter pause have also received special attention. In other characters affecting egg production there is a satisfactory degree of uniformity in the flock.

**A Study of Fertility Cycles in Males.** (F. A. Hays.) In addition to the histological study of stages of spermatogenesis in males of different ages and at different seasons, still under way, attention has been given to fertility tests of males in natural matings throughout the summer. During this period the oldest male (36 months old) declined in fertility from 81 percent to 45 percent. The 24-



months-old male began with 100 percent fertility, declined to 74 percent in mid-June, but returned to 100 percent fertility in late July. The young male (12 months old) showed consistent fertility throughout the 10-week period, but his record was never equal to that of the 24-months-old male. On the female side, yearling hens were consistently higher in fertility than either old hens or pullets.

**Miscellaneous Genetic Studies.** (F. A. Hays.) Linkage studies between genes for shank feathering, comb form, and mottled ear lobes in Rhode Island Reds will soon be concluded. The dominant sex-linked gene has been eliminated so that stocks of crossbreds that carry only the autosomal gene E' are being developed. Progress is being made on a new method for separating the sexes in Rhode Island Red Chicks on the basis of down color. A gold-barred strain is being developed for auto-sexing chicks. The effect of ultra-violet irradiation on mutation rate is being studied. Selective breeding for abnormal sex-ratios is being carried on.

**Alkaline Phosphates and Egg Shell Formation.** (Marie S. Gutowska and R. T. Parkhurst, with the cooperation of E. M. Parrott and R. M. Verberg of the Chemistry Department.) Studies were conducted to throw more light on the question whether or not alkaline phosphatase is a factor in egg shell formation. It was found that:

1. The physiological mechanism of the deposition of calcium in the egg shell was independent of a local phosphatase activity factor in the shell gland (uterus) of the hen.

2. The phosphatase activity in the blood plasma of the laying hen seemed to be related to a definite genetic constitution of the hens—high productivity and good egg shell strength.

3. The deposition of calcium in the egg shell was based on a different mechanism than the calcification of the bones.

4. Phosphatase activity was very low in the shell gland, in the oviduct, and in the ova of the laying hens as well as in their bones at the time of shell formation. It was considerably higher in the blood plasma, coming within the lower range found in human blood.

5. The necessary transformation of the colloid compound containing calcium and phosphorus, and yielding calcium for the egg shell, appeared to take place in the blood itself; the shell gland acting, probably, only as an excretory organ for calcium.

**Crab Meal as a Replacement for Fish Meal in the Laying and Breeding Rations.** (Raymond T. Parkhurst and Emery J. Jefferson with C. R. Fellers of the Department of Horticultural Manufactures cooperating.) In further studies in which crab meal replaced fish meal on an equal-protein basis (4 pounds for 2.5 pounds) in the Massachusetts complete all-mash laying ration, corn dried distillers grains with solubles, corn distillers dried solubles, and fermentation solubles (with soybean oil meal) also replaced all the dried skimmilk in the ration.

The results confirmed previous conclusions that crab meal can replace all of the fish meal in the ration used, in which adjustment was made for the higher mineral content of the crab meal. Comparable egg production, egg weight, body weight, feed consumption, feed efficiency, egg quality, hatchability and chick quality were also obtained when the distillery and fermentation by-products replaced the dried skimmilk.

In the groups with Red-Rock crosses, the percentage hatchability of fertile eggs was higher for the rations containing skimmilk than for those containing distillers dried solubles, whether used with fish meal or crab meal and, in both cases, was higher for fish meal than for crab meal. For Rhode Island Reds, the



percentage hatchability of fertile eggs was higher for fish meal than for crab meal when used with distillers grains with solubles; but was higher for the crab meal when used with fermentation solubles and soybean oil meal.

**Corn Dried Distillers' By-products in Laying Rations.** (R. T. Parkhurst, C. R. Fellers, and J. W. Kuzmeski.) Complete or unsupplemented all-mash diets were fed to Rhode Island Red pullets in laying cages. All the dried skim milk (2.5 percent) was replaced by an equal amount of dried distillers' by-products from mashes containing a high percentage of yellow corn. The by-products tested were the "screenings" or conventional light grains; the "grains," which were the grains with solubles or dark grains containing the residue (screenings) with which were dried the screened condensed stillage (solubles); and the "solubles", obtained by drying the stillage, after removal of the alcohol and "screenings."

The rations containing these by-products, each supplemented with meat-scrap, gave as good production results as meatscrap and dried skim milk, as indicated by percentage egg production, egg weights, body weight gains and egg quality. Mortality was low in all groups. Similar production results were obtained when fish meal replaced meatscrap as a supplement to "grains" and to "solubles". Hatchability was better when the "solubles" were fed. With either fish meal or meat scraps, "solubles" were comparable to milk in results obtained. With fish meal, "grains" also gave good hatchability.

**Dried Cereal Grasses in Starting Rations.** (R. T. Parkhurst, J. H. Vondell, and J. W. Kuzmeski.) Dried cereal grasses at levels of 1.25 and 2.5 percent adequately replaced dehydrated alfalfa meal at a 5 percent level in a meatscrap basal ration in which the vitamin D was obtained from D-activated animal sterol. In a similar comparison involving the 1942 (revised) New England College starter, equally good results were obtained with a low cost ration containing 15 percent soybean oil meal, dry vitamin D, and both dried cereal grasses and alfalfa meal, provided both fish meal and meatscrap were used. Results were not satisfactory when meatscrap was the only animal protein concentrate included in the ration.

## DEPARTMENT OF VETERINARY SCIENCE

### J. B. Lentz in Charge

**Poultry Disease Control Service.** (H. Van Roekel, K. L. Bullis, O. S. Flint, and M. K. Clarke.)

1. *Pullorum Disease Eradication.* During the 1941-42 testing season 366 chicken flocks and 31 turkey flocks were tested for pullorum disease. The results from this service are reported in a separate bulletin issued for that purpose.

2. *Diagnostic Service.* A total of 2,180 specimens in 498 consignments were examined. Personal delivery of specimens was made in 252 cases. The specimens may be classified as follows: 1,932 chickens, 190 turkeys, 11 foxes, 9 mink, 8 each of goat feces and pigeons, 4 each of pheasants and rabbits, 3 each of canine feces and geese, 2 each of dogs and quail, and 1 each of equine feces, feed, parakeet, and sheep.

It is encouraging to note that avian tuberculosis and fowl typhoid were not encountered during the year. The former has not been widespread in recent years, but fowl typhoid began to reach serious proportions until 1939, when educational activities by the County Extension Services and the Massachusetts Division of Livestock Disease Control were apparently effective in checking further

spread. Pullorum disease is rarely encountered in chicks where owners have adopted effective measures for the eradication and prevention of this disease. Twelve new foci of fowl cholera infection were identified during the year. Fowl cholera has been found on 53 premises during the past 10 years. This disease continues to become more widespread and of greater economic importance. Listerellosis was identified in one chicken, but apparently was not a source of great trouble in the flock in which it was encountered. The 69 tumors encountered were classified on the basis of gross examination as lymphocytoma 35, embryonal nephroma 9, myelocytoma 7, fibrosarcoma 5, hemangioma 4, fibroma 2, not identified 2, hematoma 1, leiomyoma 1, and myxoma 1.

The 190 turkeys were received in 48 consignments. The diseases encountered most frequently were coccidiosis, paratyphoid, ulcerative enteritis, and enterohepatitis. Four cases of pullorum disease were poults shipped in from outside of the State. Swine erysipelas was detected in September in two flocks which were being reared in confinement. Limited observations suggest that this infection is apt to be encountered earlier in the season in birds reared in confinement than in birds reared on range; also that such an outbreak may be controlled by letting the birds out on range. This reduces direct contact between birds and stops much of the feather picking.

3. *Flock Mortality Studies.* Morbid and dead birds from the flock maintained at the College for genetic studies have been examined to determine the causes of mortality and to furnish information for experiments in genetics. This is a continuation of work similar to that conducted in former years. During the fiscal year, 340 birds were examined. Since these represent birds hatched over a period of five years, major emphasis is placed on the group which finished its first laying year during the past fiscal year. From the birds hatched in the spring of 1941, a total of 331, representing 242 females and 89 males, have been examined. No extensive outbreak of any particular disease was noted during the year, but the recognition of 13 cases of aspergillosis was unusual. Fowl paralysis was noted in an increased number of birds, despite efforts to effect a reduction through elimination of families showing a high incidence of the disease. Over three-fourths of the cases of fowl paralysis noted were in birds which had not reached sexual maturity. Fowl paralysis was noted more frequently than any other disease. Other conditions noted in order of frequency were kidney disorders, tumors, reproductive disorders, and cannibalism. Pathological conditions in birds more than 18 months of age were quite similar to those in the younger birds, except that the percentages of leiomyoma and carcinoma increased markedly.

4. *Salmonella Types Isolated.* Paratyphoid organisms isolated from diseased specimens were identified as to type. A total of 15 strains was recovered from consignments received from 10 different flocks. Twelve strains were *S. typhimurium*, two were *S. newport*, and one was *S. derby*. The *S. typhimurium* strains were isolated from two pigeons and ten turkeys (five poults and five mature birds). The *S. newport* and *S. derby* strains were recovered from poults. In one instance *S. typhimurium* and *S. derby* were isolated from the same flock, but the stock originated from two different sources which may account for the presence of the two types.

We are greatly indebted to Dr. Philip Edwards, Department of Animal Pathology, University of Kentucky, Lexington, Kentucky, who identified these strains as to type.

5. *Avian Encephalomyelitis.* During the past year studies of avian encephalomyelitis were continued. Serial passage of this virus in young chicks has reached the 128th transfer. No perceptible change in the nature of the virus has been

observed. Chicks hatched from eggs laid by laboratory breeding stock revealed evidence of avian encephalomyelitis at hatching time. This observation further substantiates previous findings at this laboratory that this infection may be egg-borne.

6. *Infectious Bronchitis.* During the past year investigations in the control of infectious bronchitis were continued with the cooperation of the Extension Service and the Massachusetts Division of Livestock Disease Control. The 14 flocks inoculated with a laboratory strain of live infectious bronchitis virus in the summer of 1941 passed through the laying season without contracting the disease. In two instances evidence of respiratory infection was observed, but infectious bronchitis was not definitely diagnosed.

The results of these field investigations were received with great enthusiasm by other flock owners whose flocks had experienced this disease. During 1942 the program was extended to additional flocks in which the infection had previously been observed. Susceptible birds were inoculated or exposed to infection before reaching sexual maturity. In most instances post-inoculation reactions were favorable. However, it was noted that concomitant infections or diseases and climatic and management factors play a definite role in the response of the flock to infectious bronchitis virus. Mature birds which were regarded as immune to the infection due to previous exposure failed in every instance to contract the disease from the inoculated young stock. The results of the field trials appear encouraging, but before a practical control program is inaugurated further critical tests should be conducted.

Investigations have also been continued to develop a reliable method of detecting birds that have been exposed to infectious bronchitis infection. Such a method will serve as a guide in using this virus only in flocks that have had the disease.

7. *Farm Department Brucellosis Control and Eradication.* The laboratory cooperated in this work by testing 639 bovine blood samples by the standard tube agglutination method.

**Studies of Neoplastic and Neoplastic-like Diseases.** (Carl Olson, Jr.) Progress under this study was interrupted by Dr. Olson's enlistment in military service and therefore no conclusive report is possible at this time.

## WALTHAM FIELD STATION

Waltham, Massachusetts

Ray M. Koon, in Charge

The members of the research staff of the Waltham Field Station are assigned to the unit by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Reports of these departments give results of investigations conducted at this station.

**Soil Testing Service.** Testing soil for commercial vegetable growers, mushroom growers, florists, nurserymen, greenkeepers, arborists, vendors of loam, and home gardeners has long been regarded as an important service which the Field Station has rendered. More recently this program has been extended to include service to the State Department of Public Works, the Metropolitan District Commission, Works Project Administration, U. S. Army Engineers, and town and city administrations. There is no doubt that this effort is effective, particularly when the soil test is followed by a personal interview between the client and the technician. The total number of soil samples tested in 1942 was 6134.

**Field Day.** Because of the shortage of gasoline and tires, and the lack of farm machinery for demonstration purposes, this annual meeting, which would have been the twenty-fourth, was not observed. Special groups and individuals, however, interested in certain particular experiments and trials visited the Station at opportune times. Among them were the New England Carnation Growers Association, Boston Market Gardeners Association, Greenkeepers Club of New England, Society of American Florists and Ornamental Horticulturists, Massachusetts Fruit Growers Association, U.S.D.A. Club, New England Seedsmen's Association, and the New York-New England Fruit Spray Specialists.

## PUBLICATIONS

### Bulletins -

- 388 Annual Report for the Fiscal Year Ending November 30, 1941. 108 pp. illus. February 1942.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

- 389 Production and Prices of Milk in the Springfield-Holyoke-Chicopee Milkshed in 1935. By Alfred A. Brown and Mabelle Booth. 32 pp. illus. February 1942.

A comprehensive understanding of the productive organization and the marketing disposal facilities of the fluid milk industry is a necessary basis for sound marketing regulation. To this end, the investigation reported here was undertaken.

- 390 The Composition and Nutritive Value of Potatoes with Special Emphasis on Vitamin C. By William B. Esselen, Jr., Mary E. Lyons, and Carl R. Fellers. 19 pp. March 1942.

Potatoes enjoy a prominent position in the American diet. It is the purpose of this study to evaluate the nutritive properties of this popular vegetable, with special emphasis on the value of the cooked potato as a source of vitamin C.

- 391 A Survey and Study of Spontaneous Neoplastic Diseases in Chickens. By Carl Oslon, Jr., and K. L. Bullis. 56 pp. illus. April 1942.

Neoplastic diseases (tumors) cause much loss to the poultry industry. This collection of cases of neoplasia gives information of the characteristics and relative incidence of the different types.

- 392 Blooming Dates of Some Selected Hardy Perennials. By Harold S. Tiffany. 55 pp. April 1942.

A flower lover's ambition is to have some blooms available in the garden at all times during the growing season. This bulletin should be of service in the selection of perennials for that purpose.

- 393 Bay State, A Red Forcing Tomato Bred for Resistance to Leaf Mold. By E. F. Guba. 8 pp. illus. June 1942.

Leaf mold is a devastating disease of tomato in greenhouses and its control is difficult and expensive. This bulletin describes a new greenhouse tomato which combines resistance to certain strains of the fungus with desirable commercial fruit type.



- 394 The Control of Damping-off of Vegetables by Formaldehyde and Other Chemicals. By W. L. Doran, E. F. Guba, and C. J. Gilgut. 20 pp. June 1942.

Damping-off is one of the most serious problems of the vegetable grower, and the results here reported should provide safer and more effective control of the disease in hotbeds and greenhouses.

- 395 Preparation and Use of Artificial Manures. By Karol J. Kucinski. 12 pp. illus. July 1942.

The real or assumed dependence of crop production upon animal manures has encouraged this attempt to provide an artificial substitute.

- 396 Breeding Rhode Island Reds for Rapid Feathering. By F. A. Hays and Ruby Sanborn. 24 pp. illus. September 1942.

Rapid chick feathering, particularly over the back region, is a very valuable character in general purpose fowls. This study was carried on over a long period to discover a reliable method for fixing this character in Rhode Island Reds.

- 397 A Civilian Program for Tree Protection. By Malcolm A. McKenzie. 32 pp. illus. December 1942.

Public appreciation of shade trees in Massachusetts is evidenced by the extensive and varied planting throughout the State. This bulletin, prepared primarily to promote municipal tree management, also suggests methods of tree care in general.

### Control Bulletins

- 112 Twenty-second Annual Report of Pullorum Disease Eradication in Massachusetts. By the Poultry Disease Control Laboratory. 11 pp. June 1942.
- 113 Inspection of Commercial Feedstuffs. By Philip H. Smith. 25 pp. September 1942.
- 114 Inspection of Commercial Fertilizers and Agricultural Lime Products. By Fertilizer Control Service Staff. 48 pp. October 1942.
- 115 Seed Inspection. By F. A. McLaughlin. 94 pp. December 1942.

### Meteorological Bulletins

- 637-648, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By C. I. Gunness. 4 pp. each.

### Reports of Investigations in Journals

- 385 The Effect of Storage on Carbohydrates of the Ebenezer Onion. By Emmett Bennett. Amer. Soc. Hort. Sci. Proc. 39:293-294. 1941.
- 399 Scoring Baked Potatoes for Texture. By Monroe E. Freeman. Food Res. 6 (6):595-598. 1941.
- 401 A Study of Neoplastic Disease in a Flock of Chickens. By Carl Olson, Jr. Amer. Jour. Vet. Res. 3(6):111-116. 1942.
- 403 Report on Soluble Chlorine in Feeding Stuffs. By John W. Kuzmeski. Assoc. Off. Agr. Chem. Jour. 25 (4):870-874. 1942.
- 406 Vitamin Content of Green Snap Beans. Influence of Freezing, Canning, and Dehydration on the Content of Thiamin, Riboflavin, and Ascorbic Acid. By Kenneth T. Farrell and Carl R. Fellers. Food Res. 7 (3):171-177. 1942.

- 412 Studies in Mineral Nutrition of Laying Hens. I. The Manganese Requirement. By Marie S. Gutowska and Raymond T. Parkhurst. Poultry Sci. 21 (3):277-287. 1942.
- 413 Studies in Mineral Nutrition of Laying Hens. II. Excess of Calcium in the Diet. By Marie S. Gutowska and Raymond T. Parkhurst. Poultry Sci. 21 (4):321-328. 1942.
- 415 A Device for Marking Fields on Microscope Slides. By Carl Olson, Jr. Jour. Lab. and Clin. Med. 27 (7):939-940. 1942.
- 417 The Significance of Tannic Substances and Theobromine in Chocolate Milk. By William S. Mueller. Jour. Dairy Sci. 25 (3):221-230. 1942.
- 418 Experimental Autoecism and Other Biological Studies of a Gall-Forming Peridermium on Northern Hard Pines. By Malcolm A. McKenzie. Phytopathology 32 (9):785-798. 1942.
- 419 Report on Zinc. By E. B. Holland and W. S. Ritchie. Assoc. Off. Agr. Chem. Jour. 25 (2):393-394. 1942.
- 421 Maintaining Fertility Levels in Massachusetts Pastures. By W. G. Colby. Soil Sci. Soc. Amer. Proc. 6 (1941):281-284. 1942.
- 422 The Inheritance of Blossom Type and Blossom Size in the Peach. By J. S. Bailey and A. P. French. Amer. Soc. Hort. Sci. Proc. 40:248-250. 1942.
- 423 Relative Inhibition of Microorganisms by Glucose and Sucrose Sirups. By L. Tarkow, C. R. Fellers and A. S. Levine. Jour. Bact. 44 (3):367-372. 1942.
- 424 Further Studies on the Control of Preharvest Drop of McIntosh. By Lawrence Southwick. Amer. Soc. Hort. Sci. Proc. 40:39-41. 1942.
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- 426 Trunk Diameters of Young Apple Trees on Clonal Stocks. By J. K. Shaw. Amer. Soc. Hort. Sci. Proc. 40:269-271. 1942.
- 427 An Improved Orange Juice Concentrate. By A. Sedky, C. R. Fellers, and W. B. Esselen, Jr. Fruit. Prod. Jour. 21 (5):136-138. 1942.
- 428 An Improved Orange Marmalade of High Vitamin C Content. By A. Sedky, C. R. Fellers, and W. B. Esselen, Jr. Fruit Prod. Jour. 21 (6):170-172, 185, 189. 1942.
- 429 The Availability of the Iron of Cocoa and of Iron-Fortified Cocoa Mixtures. By Faye Kinder, W. S. Mueller, and Helen S. Mitchell. Jour. Dairy Sci. 25 (5):401-408. 1942.
- 430 The Nontoxicity of Levulinic Acid. By R. G. Tischer, C. R. Fellers and B. J. Doyle. Jour. Amer. Pharm. Assoc. Sci. Ed. 31 (7):217-220. 1942.
- 431 Tomato Catsup as a Source of Vitamin C. By W. B. Esselen, Jr., and H. Fram. Jour. Home Econ. 34 (9):677-678. 1942.
- 432 The Control of Wood Decay. By Malcolm A. McKenzie. Pests and Their Control, March 1942.
- 433 Cider-Apple Jelly. By S. G. Davis, C. R. Fellers, and A. S. Levine. Fruit Prod. Jour. 21 (9):260-261, 283. 1942.
- 434 Measurement of Texture in Baked-Potato Tissue. By Monroe E. Freeman. Food Res. 7 (6):451-458. 1942.
- 435 Geography of New England Soils. By A. B. Beaumont. Econ. Geog. 18 (2):203-208. 1942.
- 437 Propagation of Garden Sage, *Salvia officinalis* L., by Cuttings, Especially by Cuttings Taken in Winter. By W. L. Doran and A. M. Davis. Amer. Nurseryman 76 (5):12. 1942.

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- 439 Bacteriological Study of Chocolate Milk. By James E. Fuller, W. S. Mueller, and R. W. Swanson. Jour. Dairy Sci. 25 (10):883-894. 1942.
- 440 Cranberry Storage Tests. By C. I. Gunness. Cranberries, September 1942, pp. 7, 10.
- 441 The Food Value of Mushrooms (*Agaricus campestris*). By E. E. Anderson and C. R. Fellers. Amer. Soc. Hort. Sci. Proc. 41:301-304. 1942.
- 442 Effect of Apples, Tomatoes, and Dates on Urinary Acidity and Blood Alkali Reserve. By K. G. Shea and C. R. Fellers. Jour. Amer. Dietet. Assoc. 18 (7):454-457. 1942.
- 444 Composition and Utilization of the Beach Plum. By S. G. Davis and A. S. Levine. Fruit Prod. Jour. 21 (12):361-364. 1942.
- 445 Heat Capacity and Bound Water in Starch Suspensions. By Monroe E. Freeman. Arch. Biochem. 1 (1):27-39. 1942.
- 449 A Comparison of Four Methods for Determining Vitamin C with a 25-Day, Weight-Response Bioassay. C. F. Dunker, C. R. Fellers, and W. B. Esselen, Jr. Food Res. 7 (4):260-266. 1942.
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- 454 The Hemicelluloses of Forage Plants. By Emmett Bennett. Jour. Biol. Chem. 146 (2):407-409. 1942.
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- Third List of Fungi of Nantucket. By E. F. Guba and E. V. Seeler. Rhodora 44:167-175. May 1942.
- Progress Report Including Transcriptions of Certain Papers Presented at the Ninth Annual Five-Day Short Course for Tree Wardens and Other Workers with Trees, M. S. C., March 30-April 4, 1942.
- Indoor Culture of Plants. By L. H. Jones. p. 4.
- Ferns in the Roadside Landscape. By A. Vincent Osmun. pp. 12-13.
- Municipal Tree Programs in National Defense. By Malcolm A. McKenzie. pp. 29-30.
- The Present Status of the Dutch Elm Disease and the Program for Massachusetts. By Malcolm A. McKenzie. Rpt. of 44th Annual Meeting of the Mass. Forest and Park Assoc., January 29, 1942.
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MASSACHUSETTS  
AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 417

AUGUST 1944

Annual Report

1860-1-1942-  
For the Period Ending June 30, 1944

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The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

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MASSACHUSETTS STATE COLLEGE  
AMHERST, MASS.

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# MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

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HUBBARD, CLIFFORD C., Norton.....	1946
WHITMORE, PHILIP F., Sunderland.....	1948
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†DEMISEY, PAUL W., Horticulture	

\*In charge    †At East Wareham    ‡At Waltham    §On Military Leave.

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# ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1943-44

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## DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

**Effect of Public Regulation of Milk Marketing upon the Organization of Milksheds of Massachusetts Markets.** (A. A. Brown.) Programs developed as wartime measures by various Federal agencies currently overshadow the effect of local marketing regulations. Except as the prestige of pre-war institutions is brought to the support of the War Food Administration, Office of Price Administration, or Office of Defense Transportation, their influence is dormant.

Data are being assembled as they become available on (1) the efforts of the War Food Administration to maintain and stimulate milk production with feed subsidies; and (2) the efforts of the Office of Price Administration to maintain milk consumption through the establishment of ceiling prices on sales at retail and wholesale.

Conflicting forces are present in various programs; forces which in the long run may prove to be very detrimental to the public interest. Shortages in labor, materials, and equipment, now faced by the industry as a result of the concentration of resources to war purposes, would normally result in the development of efficiencies. Some of these are coming but in a way which it was hoped might be avoided. Greater efficiency in city distribution has long been sought. Operations were multiplied along the lines of an "industrial make-work" program. Order could have been brought out of this turbulent operation through more positive public control or through concentration by the industry. The larger elements appear to be absorbing the smaller ones or the weaker ones.

The number of handlers in Boston in May 1944 was 284 compared with a 1938-1940 three-year average of 441. All group handlers, handler-buyers and producer-handlers showed approximately uniform numerical reductions of 49-59, although the handler group had the greatest proportionate reduction of 40 percent.

Similar changes are also shown for the Lowell-Lawrence market although differences in reports do not permit precise monthly comparisons. In this market for the month of April the total number has declined from 232 in 1941 to 158 in 1944. Producer-handlers dropped most from 111 to 69; a reduction of 37 percent. Other markets in the state are undergoing similar changes. Tabulations of these have not yet been made.

Rulings of the OPA and ODT are in conflict on the matter of milk trucking charges in the country; one prohibits reductions; the other, increases (as a result of conservation measures). With charges frozen, one of the strongest inducements toward the efficient use of trucking in the country is eliminated.

**Transportation Requirements of Rural Communities in Massachusetts.** (A. A. Brown.) Attention has been concentrated under the study towards the development of truck conservation programs in the dairy field.

Studies of operations have been completed in four major markets: Worcester, Boston, Brockton, and Fitchburg. Studies are continuing in Springfield and Lowell-Lawrence.



As a result of these studies and the recommendations developed therefrom, daily savings in mileage for four cities now approximate 1329 or 8.4 percent. The range is from 3.9 percent in the Boston market to 25.8 in Brockton.

**The Development of Statistical Data as Controls to Livestock Production Programs.** (A. A. Brown.) Development of the sample areas has been completed for the State. Attention is now being focused on the usefulness of the square mile grids as a means of sampling Massachusetts agriculture. In Hampshire County where the checking is nearing completion, there appears to be some doubt as to the uniform relationship between land distribution and farm distribution.

**Organization and Management of Poultry Farms in Massachusetts.** (C. R. Creek.) Poultry farming was more profitable in Massachusetts in 1943 than in any of the previous four years, according to the summary of Poultry Account Records. For the farms reporting, net farm income averaged \$3660 per farm, which was 53 percent greater than in 1942, double the return in 1941, more than three times greater than in 1940, and two and one-half times greater than in 1939. The size of the laying flock was about 750 birds each year, but the type of business has changed. The proportion of cash receipts from the sale of hatching eggs, chicks, and pullets has more than doubled in the past two years over 1939 and 1940. Some increase was noted in broiler sales in 1943. Other factors responsible for increased returns were higher egg production per hen, much higher prices for eggs in 1942 and 1943, and a more favorable feed-egg ratio because of these higher prices.

The one-third of the farms most profitable in 1943 earned net farm incomes of \$6740 per farm, while the one-third least profitable earned only \$940 per farm. Some of the reasons for the higher net incomes are: size of business three times greater, a greater proportion of cash receipts from hatching eggs and chicks, an average production of 44 more eggs per hen, 7.5 cents a dozen higher price received for eggs, 4 cents per dozen lower cost of feed, 1.5 less dozens of eggs required to purchase 100 pounds of feed for the laying flock, and more efficient use of labor.

Records for 21 identical poultry farms for 1942 and 1943 showed average net farm incomes of \$2530 and \$3685. The more important reasons for the higher returns in 1943 were: an increase of 12 cents per dozen in average price received for eggs, an increase of 56 percent in sales of broilers, an increase of 112 percent in sales of chicks and pullets, an increase of 67 percent in sales of hatching eggs, a more favorable feed-egg ratio, and more work accomplished with less months of labor.

**Labor Saving Methods and Practices on Massachusetts Farms.** (C. R. Creek.) Studies made during the 1943 season on Iceberg lettuce indicated that a 3-man harvesting crew (2 men cutting and 1 packing into crates) was the most efficient, fastest, and least fatiguing method of field harvesting. In the packing shed a 6 to 8 man crew operating a "line-system" for washing, icing, fastening crates, and loading crates was the most efficient. Output in crates per man per hour was highest and the work was much less fatiguing than by other methods where the crates were lifted and carried back and forth several times during the packing shed operations.

The "line-system" was used in harvesting broccoli in the field as well as in the packing shed operations on a farm where all work was accomplished with a minimum of effort and high output per man. The broccoli was lifted from the ground once (when cut). Tables and roller conveyors were used to eliminate

lifting and carrying in the packing shed. Bunching of the broccoli was paid for on a piece work basis at a favorable rate and the work was done more quickly because of this incentive pay.

**Loan Performance on Low Income Farms in Massachusetts.** (C. R. Creek.) Through December 1943, loans had been repaid in full for 42 out of 92 cash-crop loans made since 1936 by the Farm Security Administration in the three Connecticut Valley counties of Massachusetts. Payments were generally made in large amounts from the sale of onions, potatoes, or tobacco. Two years (1942 and 1943) of good yields and high prices enabled these crop farmers to pay off delinquent loans as well as the 1943 operating loan. Total loans were \$2345 per farm for a period of 1 to 7 years' duration and the average loan was \$938 annually. Interest on the loans which were paid amounted to \$72 per loan. The average length of these crop loans that had been repaid was about 1.5 years.

Loans on livestock-crop farming units were made on 74 diversified farms from 1936 through 1943 and 40 had been repaid by the end of the latter year. These loans were generally repaid in small monthly installments from the sale of milk and eggs. Larger payments were made occasionally from sales of crops, cattle, or poultry. Auctions of livestock and equipment on dairy and poultry farms were necessary to close delinquent loans on one-fourth of the farms. Five borrowers had ceased to operate their farms since 1941 and had made large payments through the sale of livestock and farm machinery. These loans were finally closed by payments from wages earned in industrial employment. Sales of crops and livestock products were used to repay the remainder of the loans. Total loans were \$1358 per farm for a period of 2 to 7 years and the average size of loan was \$823 annually. Interest on the loans which were repaid amounted to \$61 per loan. The average length of these loans was about 2.5 years.

Repayment of loans has been more satisfactory on the cash crop farms than on those farms having livestock enterprises. Crop losses from floods, frost, and hail have prevented some crop farmers from paying off their loans, but most of the delinquent livestock loans were due to poor management.

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## DEPARTMENT OF AGRONOMY

Walter S. Eisenmenger in Charge

**Tobacco Projects.** (Walter S. Eisenmenger and Karol J. Kucinski.)

*Brown Root Rot of Tobacco.* The experiment was designed to determine the effect of the preceding crop on the yield and crop index of tobacco. The various preceding crops were planted at three different times during the season. The earliest matured completely; the two others did not mature. All were plowed under in the spring after the tops had been almost completely dehydrated by natural freezing, thawing, and drying. Those crops which had matured completely and contained a high percentage of fiber in the vegetative tissue reacted unfavorably to the tobacco crop.

The amount of material to be plowed under was not an index of the yield or quality of tobacco. Sunflowers and Jerusalem artichokes afforded abundant material to be turned under; yet the tobacco crops after these plants were among the best.

Crops such as sunflower, artichoke, tobacco, and fallow might be classified as the better preceding crops for tobacco; buckwheat, barley, rape, millet, wheat, and rye are less satisfactory; and such crops as corn, oats, sudan grass, and sorghum are consistently unfavorable when used in rotation with tobacco.

**Black Root Rot of Tobacco.** (C. V. Kightlinger.) Several strains of Havana Seed have been produced which are capable of producing high yields of tobacco of superior type and quality in soils infested with the organism that causes black root rot as well as in soils free from diseases. Havana Seed 211 is the best of the strains that have been tested thoroughly, but it is not entirely acceptable to all cigar manufacturers. In spite of this fact, this strain is grown in large acreage in the Connecticut Valley and has been an important factor in increasing the average yield per acre and in improving the quality of Havana Seed tobacco produced in the Valley during the last several years.

New strains of Havana Seed are being produced, some of which seem to possess improvements in type, quality, and habits of growth, especially in leaf conformation and in earlier maturity. Two of these strains are being tested in commercial production, and also in the manufacture of cigars by leaders in the business.

**Brown Root Rot of Tobacco.** (C. V. Kightlinger.) Since brown root rot often develops on tobacco following other crops, one phase of this study is concerned with the growing of a number of crops deleterious to succeeding crops of tobacco, to see whether unusually large applications of fertilizer will reduce the occurrence and severity of brown root rot on following crops of tobacco.

The other phase of the work is a study of tobacco grown continuously, to see whether brown root rot can be produced by a low state of fertility and then to study the possible corrective effect of different fertilizing materials.

It has taken several years to accomplish the preliminary work of getting the soil into the desired condition for a study of the main objective of the project—how low fertility of soil and inadequate fertilization affect the development not only of brown root rot of tobacco, but also of root ailments of several other farm crops.

**Disinfection of Tobacco Seedbeds.** (C. V. Kightlinger.) Fall treatments with chloropicrin and calcium cyanamid used singly and in combination, fall and spring steaming, and fall and spring treatments with formaldehyde were used. No noticeable damping-off, bed-rot, or other root diseases of tobacco seedlings occurred in the seedbeds during the season; therefore no definite information could be obtained from this year's experiment about the value of any of the soil treatments as disease control measures.

The spring steamed and the calcium cyanamid treated areas could not be kept moist enough for satisfactory growth of tobacco seedlings because of a temporary change in physical condition of the soil due to the treatments. A further difficulty on the calcium cyanamid treated areas was an accumulation of residual substances on and near the surface of the soil, which seemed to be harmful to tobacco seedlings.

Tobacco seedlings grew much more vigorously in the fall steamed and the chloropicrin treated areas and somewhat more vigorously in the formaldehyde treated areas than they did in the untreated areas. If this was due entirely, or even in large part, to the control of disease, then very slight infections of root diseases retard the growth of tobacco seedlings much more than is generally recognized. It is reasonable to believe, however, that these treatments had other invigorating effects on plant growth besides the control of diseases.

Fall steaming and chloropicrin treatments were highly effective in the control of weeds in the seedbeds, the fall steaming being somewhat more effective. Formaldehyde gave only slight control of weeds. No weeds grew in the spring steamed and the calcium cyanamid treated areas at any time during the season.



**The Absorption by Food Plants of Chemical Elements Important in Human Nutrition.** (Walter S. Eisenmenger and Karol J. Kucinski.) When the individual ions were applied to the soil at the rate of 200 p.p.m., the percentage intake by plants was greater for magnesium, sodium, and potassium than for calcium. Chlorine, bromine, and iodine intake was higher than the intake of phosphorus or sulfur when equal parts per million were added to the soil.

The place of the plant in the evolutionary scale, as well as the individual ion, is a factor in the increased intake. A more highly developed plant — lettuce — did not increase its content of calcium, magnesium, sodium, and potassium as much as did those lower in the evolutionary scale — celery, beets, cabbage, and beans — when the respective ions were added equally to the soil.

**The Intake by Plants of Elements Applied to the Soil in Pairs Compared to the Intake of the Same Elements Applied Singly.** (Walter S. Eisenmenger and Karol J. Kucinski.) In nearly all cases when two cations were added to a plot, each at the rate of 250 p.p.m., the intake of the ions was depressed in comparison with the intake when each was added singly at the same rate. The intake of two ions added in pairs complicates the interpretation. It is probable that, when there is relative abundance of one ion and little of another, the plant takes more of the abundant ion than is necessary for metabolism. It has even been suggested that one element may regulate the semi-permeable membrane of the plant.

From a practical point of view, it has been observed that liberal potassium applications may lead to magnesium deficiency in plants.

**Magnesium Requirements of Plants.** (Walter S. Eisenmenger and Karol J. Kucinski.) Numerous plants of different botanical families have been grown on a plot, part of which is low in magnesium. Enough magnesium is present in the so-called magnesium-deficient soil to produce normal growth of some plants, but not of others.

Preliminary work suggests that the less evolutionally developed flowering plants need more magnesium in their growing medium than do the plants in the higher orders. No plants of the families Compositae, Chenopodiaceae, Amaranthaceae, or Labiatae and only one member of the family Gramineae have shown deficiency. All of the lower families have shown deficiency to a marked degree, among these being Ranunculaceae, Magnoliaceae, Ulmaceae, Malvaceae, Geraniaceae, Rosaceae, and others.

It would seem that, as far as needs for normal growth are concerned, magnesium is an older element than calcium.

**Long-Time Field Fertility Tests.** (Walter S. Eisenmenger and Karol J. Kucinski.) About fifty-five years ago a series of so-called soil test plots was inaugurated to study the effects on the soil and crops of a long-time fertilizer program. Various types of crops have been grown on these plots but the original system of fertilization has always been followed, including check plots which have been left unfertilized during the entire period. Recent results, with hay as an indicator crop, showed that the fertility level of all the plots was much higher on the limed than on the unlimed portions. The unlimed portions of the check plots showed crop failure and indications of nutrient deficiencies. On the complete fertilizer plot (N.P.K.), the limed area yielded about 200 percent more hay than the unlimed area. On the limed areas, the complete-fertilizer plot yielded about 50 percent more hay than the no-fertilizer plots. On the unlimed area, the plots receiving nitrogen, nitrogen plus phosphorus, and nitrogen plus potash showed an increase of about 350 percent in yield of hay over the no-fertilizer plots.



**Soil Conservation Research Projects.** (Karol J. Kucinski and Walter S. Eisenmenger.)

*Physical and Chemical Properties of Wind-Blown Soils.* During the past year laboratory tests and field observations were made to determine why certain soils are subject to wind erosion while others are not. The chemical and physical properties of the various soils were studied intensively to see whether there is any correlation between these properties and wind erodibility. A wind tunnel especially designed for local conditions has been used to supplement field observations.

It has been found that certain Connecticut Valley soils will erode at as low a wind velocity as four miles per hour, while others will not blow at much higher velocities. Most soils tested will seriously erode at wind velocities varying from 15 to 20 miles per hour. All the soils tested will blow at 35 miles per hour, except when moist. However, soils containing as much as 25 to 35 percent moisture will blow when frozen since freezing, by solidifying the water molecule, acts as a dehydrating agent. Because there was so little snow in the Valley last season, more dust storms than usual occurred during late fall, winter, and early spring. Chemical treatment of soil with such compounds as urea and lithium carbonate has greatly decreased its wind erodibility.

*Use of Snow Fencing in Controlling Wind Erosion.* On farms where wind erosion is a problem, it often happens that certain local areas or spots are much more subject to blowing than the remainder of the field. This condition may arise from a variety of causes and usually appears spasmodically in different years or under certain weather conditions. It is recognized that anything that can be used to check the velocity of the wind will have a very definite effect on wind erosion, and highway snow fencing equipment is being studied for use in this connection.

*Erosion Problems Arising from Changes in Land Use.* Because of the favorable economic position that potatoes have assumed in recent years, many areas that are not particularly suitable for the growing of cultivated crops have been plowed up, with the result that soil erosion problems have been developed that are deserving of serious consideration. Sheet and gully erosion are increasing yearly on some of these fields, and laboratory tests show a yearly increase in the rate of organic matter depletion. Some operators are already experiencing a decrease in potato yields and have called on the Soil Conservation Service for aid in formulating plans for the protection of their fields.

**Sunflowers and Their Possibilities.** (Karol J. Kucinski and Walter S. Eisenmenger.) Tests show that sunflowers will grow on any land which will grow corn, best results being obtained when the seed was sown, one every 18 inches in 36 inch rows, using corn fertilizer. Sunflowers are more hardy to light frost than corn and can be planted at the time it is safe to plant field corn. Depending on the season and variety, a growing period of 120 to 140 days is sufficient for maturing the seed in Massachusetts. Yields of one to two tons can easily be obtained under favorable conditions.

**Onion Breeding.** (Hrant M. Yegian.)  $F_2$  progenies from a cross between White Persian, with light leaf color, and Ebenezer, with yellow skin and dark leaf color, gave a close ratio of three yellow to one white skin bulbs. Dark leaf color was dominant over light. There was an extreme variation in leaf color in the  $F_2$  population indicating that this is a quantitative character influenced by the environment.

Storage temperature had a marked effect upon the keeping quality of the bulbs, the subsequent seed stalk development, and the amount of seed produced. Bulbs stored at 32° F. had only 2 percent soft rot, while 15 percent of the bulbs stored at 45° and 59 percent of those stored at 70° had soft rot.

Bulbs stored at 32° F. had a higher percentage of two and three seed stalks and as a group produced more seed than those stored at 45°. On an individual plant basis, however, bulbs stored at 45° produced about 0.23 grams more seed. Only 30 percent of those stored at 70° had seed stalks and these did not produce any seed. On the basis of a two years' record it is therefore recommended that onions be stored in a well-ventilated storage building at 32° at a low humidity.

Onions topped short immediately after pulling had 21 percent rot and those cured for a few days had 22.5 percent; while onions topped long immediately after pulling had 10 percent and those cured for a few days 7.5 percent rot. These onions were stored from July 21 to March 27 in a room which had heating facilities but no cooling system to prevent the rise of temperature on warm days.

**Ryegrass as a Green Manure Crop.** (Hrant M. Yegian.) The lack of organic matter in most of the onion fields in the Connecticut Valley is one of the serious problems facing the growers. In order to demonstrate that it is practicable to grow green manure crops after the set onions have been harvested and to show their relative value, domestic ryegrass, winter rye, oats, and Japanese millet were seeded on an onion field in Sunderland, Massachusetts, on July 27, 1943, after the onion crop had been harvested.

Domestic ryegrass was by far the best green manure crop because it made a rapid top growth and had a very extensive root system. Winter rye was second best.

A small section of ryegrass was left unplowed in the fall. The spring was late; consequently plowing of this strip was delayed, and it was not in as good a condition at planting time as the fall-plowed section. Because of the possibilities of a late spring it is, therefore, desirable to plow under green manure crops on onion fields in the fall, notwithstanding the fact that fall plowing will not give as good protection against soil erosion from wind or rapid run-off of rain.

**Corn Improvement Program.** (Hrant M. Yegian.) Ninety-one single crosses involving all possible combinations of fourteen inbreds were tested at this station, in cooperation with the corn breeding program at the Connecticut Agricultural Experiment Station under the direction of Dr. D. F. Jones, in order to determine the most valuable inbreds and to predict the most effective double cross combinations for this area.

An early hybrid produced by the double cross of four inbred lines, Wisconsin (CC4 x CC8) X Quebec (83 x 9), gave very satisfactory yields in 1942 and 1943. More extensive tests are being made in 1944.

A number of hybrids were tested for their general adaptability and yield, and the following are recommended on the basis of previous trials as well as the results obtained in 1943.

Very early hybrids for grain: Maine B, Wisconsin 240 and 255.

Early hybrids: Minnesota 800, 700, and 702.

Medium early hybrids: Wisconsin 355, Minnesota 602, and Cornell 29-3.

Late hybrids: Ohio M-15, DeKalb 201, Iowa 939, Ohio K24 and W46.

Silage corn, in the order of their relative maturity, beginning with the earliest: Cornell 29-3, Wood V20, Iowa 939, N.J. No. 2, Indiana 608A, U.S. 44, U.S. 13, Ohio C 92, and Wood hybrid yellow sweepstakes S. M.

**Influence of Soil Fertility on Productiveness of Pasture Species.** (Hrant M. Yegian.) The data collected in 1943 and the spring of 1944 substantiated results obtained during the preceding two years. All the species continued to respond to increases in soil fertility. Plots receiving an annual application of 600 pounds of 5-8-7 in April and June and 400 pounds in August consistently produced more grass than plots receiving 400 pounds of 5-8-7 in April and June or only one application in April.

The response to fertilizer was more pronounced during the prolonged dry weather in the spring of 1942 and 1944. Kentucky bluegrass, timothy, and redtop suffered more during periods of drought than meadow foxtail, reed canary grass, orchard grass, or smooth brome grass.

The effect of temperature upon growth varied with different grasses. Kentucky bluegrass, orchard grass, meadow foxtail, and reed canary grass grew almost as well in summer as in spring, provided there was sufficient moisture throughout the growing period.

Orchard grass, Kentucky bluegrass, and reed canary grass made rapid recovery after cutting.

Some of the grasses were non-persistent, especially at a high level of soil fertility. Perennial ryegrass was winterkilled during the winter of 1941-42, and orchard grass, meadow fescue, and rough-stalked meadow grass during the winter of 1943-44. Timothy began to thin out after the third year.

A few of the grasses made more rapid growth in the spring than others. On the first of May, 1944, reed canary grass was eleven inches tall, smooth brome grass six inches, and foxtail five inches; while redtop, Kentucky bluegrass, timothy, fowl bluegrass, and colonial bent were only three inches tall.

Redtop and fowl bluegrass gave as high a yield the first harvest year as the second and the third year; timothy produced most the second year and meadow fescue, orchard grass, and meadow foxtail, the first year; while reed canary grass, smooth brome grass, and Kentucky bluegrass gave their highest yield in the third year.

The fact that most of the species differ from each other in one or more important agronomic characteristics suggests the use of several of these well-adapted species on a farm in order to insure, through a proper scheme of management and soil fertility, a satisfactory and uniformly distributed feed supply throughout the season.

**Experiments at Amherst with Hay and Pasture Seeding Mixtures.** (W. G. Colby.) Additional data were obtained from a series of plots planted in 1940 with different hay and pasture seeding mixtures. Details of the layout of the experiment were given in a previous report (Mass. Agr. Exp. Sta. Bul. 388:14-15, 1942).

Most of the seed mixtures included in this experiment were simple ones in which one grass was seeded with ladino clover alone or with ladino clover and alfalfa. Except for the first and second years in the plots first cut for hay, alfalfa has not been an important constituent in any of the mixtures. The failure of alfalfa to become established in the pasture series and to persist in the hay-pasture series can probably be attributed to the system of grazing management which was followed.

During the first grazing season (1941) the pasture series was grazed rotationally five times. Under this heavy system of grazing only weak stands of alfalfa were established and these were lost during the following winter. In the plots first cut for hay, the alfalfa was well established before the hay was cut and a good stand was obtained in all alfalfa seedings. However after a crop of hay had been



harvested, these plots were also grazed rotationally three times each season. The heavy grazing following the removal of a crop of hay so weakened the alfalfa that most of it had disappeared by the beginning of the third season. If grazing had been restricted to one or two light grazings or if a second crop of hay, only, had been taken, alfalfa would undoubtedly have persisted much longer. Under conditions as they exist at Amherst, alfalfa is a better hay plant than a pasture plant. If alfalfa is used for pasture, cutting the first crop for hay and lightly grazing the second crop is probably the most satisfactory system of management.

By 1943, the third harvest year, wide variations were evident in the proportion of grass to ladino in the different seeding mixtures. The following grasses had eliminated most of the ladino clover: Tall fescue, orchard grass, and Kentucky bluegrass. Redtop provided strong competition but did not eliminate the clover. The most serious competitor to the ladino clover was Kentucky bluegrass. This grass appeared in all plots during the third season, whether seeded or not, with the exception of those with good stands of orchard grass or tall fescue. There was a greater proportion of bluegrass in the plots which were grazed than in those which were cut for hay and then grazed. Observations in the field together with the results of these experiments indicate rather definitely that it is neither necessary nor even desirable to include Kentucky bluegrass in a pasture seeding mixture except where the rapid establishment of a bluegrass sod is desired. To sow bluegrass with ladino clover merely reduces the effectiveness and shortens the life of the clover.

Grasses which persisted but which did not crowd out the clover were smooth brome grass (Canadian strain), meadow fescue (Svalof's early), pasture strains of orchard grass S26, S37, and S143, and perennial rye grass (O.A.C. No. 1). The smooth brome-ladino mixture continued to be one of the best mixtures in the experiment. It was the most palatable; yields were good, particularly during midsummer, and a satisfactory clover-grass composition was maintained at all times. By the end of the summer about 60 percent of the herbage was clover and 40 percent grass. Some bluegrass was present in addition to the smooth brome.

Timothy was the only grass included in the experiment which tended to be suppressed by the ladino clover. After the second grazing period in June, timothy made very little growth until cool weather in the late summer and fall.

**Response of Different Hay and Pasture Seeding Mixtures to Heavy Nitrogen Fertilization.** (W. G. Colby.) In the early spring of 1943, nitrate of soda was applied at the rate of 450 pounds per acre to half of each plot in the series with different seeding mixtures. These plots, seeded in the summer of 1940, made it possible to study the effect of liberal nitrogen fertilization on a number of the more important pasture grasses, both in stands made up largely of grass and also in stands with varying amounts of clover, chiefly ladino. The following results are of interest.

**Rate of Application:** For conditions as they existed, 450 pounds of nitrate of soda supplied too much nitrogen for best results. The weather during the spring months, particularly May, was much wetter than usual, so that the growth response was abnormally large. Serious lodging occurred in many of the hay plots, and in several of the pasture plots feed was produced for a time faster than it could be efficiently utilized. Under the circumstances, it is probable that 50 pounds of elemental nitrogen to the acre would have been more satisfactory than 75 pounds. Lodging in the hay plots smothered out most of the clover.

**Dry Matter Yields:** The first harvest on the pasture plots was made on May 27. Increases in yields as a result of nitrogen fertilization varied from no increase in the case of a poor stand of perennial rye grass and ladino clover, to more than



two and one-half times increase in yield from a practically pure stand of timothy. The average increase in yield from applied nitrogen for the nineteen different seedings was about 50 percent.

For the second harvest, on June 29, yields of the nitrogen half of the plots varied from a 22 percent decrease for the redtop-ladino clover plot to a 78 percent increase for a practically pure timothy stand. The average increase for all plots was 5.4 percent. The decrease in yield in the case of redtop is explained by the fact that the clover population was greatly reduced in the fertilized half of the plot. In the no-treatment half of the plot, where there was a fairly good stand of clover, yields were well maintained throughout the season. The results obtained at the time of the third harvest, on July 30, were similar to those obtained for the second. Of the increase in yield from additional nitrogen during the season, 94 percent was obtained at the first harvest date in May.

*Response of Different Grasses:* Timothy gave the greatest response to nitrogen fertilization, followed in turn by smooth brome grass, Kentucky bluegrass, redtop, meadow fescue, perennial rye grass, and orchard grass. The average increase in yield for four different strains of timothy (fairly pure stands) was 82.6 percent for the first harvest, 28.1 percent for the second, and 4.9 percent for the third.

*Effect of Nitrogen on the Clover Population:* The effect of nitrogen on the clover population varied greatly with different grasses. When redtop was present to an appreciable extent, additional nitrogen tended to strongly suppress the clover. For example, a redtop-ladino clover plot was made up of 80 percent redtop and 20 percent clover in the spring. By fall the nitrogen half of the plot had only 10 percent clover, while the untreated half contained 60 percent clover. Kentucky bluegrass reacted similarly to redtop.

Tall fescue and orchard grass had already crowded out much of the ladino clover before nitrogen was applied, and additional nitrogen merely resulted in the elimination of what little clover was left. Brome grass in the pastured plots gave good results, and additional nitrogen, though it increased yields appreciably, had no deleterious effect on the stand of clover.

**Time-of-Planting Trials with Smooth Brome Grass.** (W. G. Colby.) Successive summer seedings of smooth brome grass (Canadian strain) and ladino clover, both with and without a light seeding of oats, wheat, or rye, showed that early seedings were much better than late ones. Seedings made on August 19, 1942, resulted in an excellent stand of both brome grass and clover by the summer of 1943. Seedings made on September 2 resulted in a fair stand of brome grass but no ladino clover. Later seedings resulted in very poor stands of brome grass. A light seeding of oats had an injurious effect on the August seeding but was of some benefit to later seedings. Late seedings with wheat or rye showed some benefit from the companion crop.

These results indicate that summer seedings of smooth brome grass should be made early — probably not later than is safe for the summer seeding of alfalfa or ladino clover — and without a companion crop of oats, wheat, or rye.

**Winter Hardiness of Orchard Grass Strains.** (W. G. Colby.) The winter of 1943-44 was a severe one from the standpoint of winter injury to vegetation. Observations on winterkilling in a three-year-old nursery of orchard grass strains showed the following results:

1. Strains showing no apparent injury: Commercial, Scandia II, Tammisto.
2. Strains showing some injury: Brage, Tardus II, O. A. C. No. 1.
3. Strains showing severe injury: S26, S37, S143, Akaroa, New Zealand.

**Potato Seed Treatments.** (C. V. Knightlinger and H. M. Yegian.) Experimental work was done in 1943 to ascertain the comparative tolerance of potato varieties to different disinfecting seed treatments and the effectiveness of these treatments in controlling rhizoctoniosis and scab.

Several different seed treatments were used on Green Mountain, Irish Cobbler, Chippewa, Katahdin, Earlane, and Sebago potatoes which were slightly to moderately infected with rhizoctoniosis and slightly infected with scab. At the time they were treated, the potatoes were either completely dormant or just starting to sprout. The treatments used were mercuric chloride, mercuric chloride plus acid, yellow oxide of mercury, Semesan Bel, Sanoseed, Spergon, and Fernate, all of which were used carefully according to the directions.

The inorganic mercury treatments injured the tubers of Chippewa, Katahdin, Earlane, and Sebago varieties, but not the tubers of Green Mountain and Irish Cobbler varieties. The organic treatments caused no noticeable injury to the tubers of any of the varieties. None of the treatments had any significant effect on the stands of potatoes or the vigor of the plants, and no increase in yields was obtained from the use of any of the organic treatments. Careful examination of the growing plants and later examination of mature tubers at harvest time showed little or no difference in the amount of rhizoctoniosis and scab on the tubers grown from treated and untreated seed.

**Potato Variety Trials.** (Ralph W. Donaldson, Walter S. Eisenmenger, and Karol J. Kucinski.) Based on yields of marketable size, the ranking of potato varieties grown in plots at the Experiment Station during the season of 1943 were Warba, Chippewa, Irish Cobbler, Sequoia, Sebago, Green Mountain, Katahdin, Earlane, Houma, S-46592, Mohawk, Russet Rural, and Pontiac.

The ranking of the five common varieties of potatoes grown in plots, based on 10-year average (1934-1943), was Green Mountain, Russet Rural, Chippewa, Katahdin, and Irish Cobbler.

## DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

**A Study of the Mineral Elements of Cow's Milk.** (J. G. Archibald and C. H. Parsons.) The work with zinc has been completed and the results published in the April, 1944, number of the Journal of Dairy Science. Zinc oxide (10 grams per cow daily) was fed as a supplement to the ration of eight cows for a period of three months by the double reversal method. This consistently raised the level of zinc in the milk, the average being 5.1 mgm. per liter of milk as contrasted with an average of 3.9 mgm. when the cows were on a control ration.

The same procedure was followed during the past winter in the study of the element cobalt, which was fed as cobaltous acetate at the rate of one-half gram daily per cow. Results are not yet available, as the analytical work is still in progress.

**Investigation of the Merits of Legume and Grass Silage for Massachusetts Agriculture.** (J. G. Archibald and C. H. Parsons.) Practical aspects of this work during the past year have involved a trial of the following as possible preservatives:

1. Urea (10 pounds per ton of green crop).
2. Urea and molasses (urea 10 pounds, molasses 75 pounds, per ton of green crop).

3. Ground wheat (at three different rates: 100, 150, and 200 pounds per ton of green crop).

The urea when used alone proved unsatisfactory. The odor of the silage was very objectionable and an undesirable type of fermentation had taken place as indicated by the high pH (5.6), excessive amounts of butyric acid and volatile bases, and complete absence of lactic acid. The one point in favor of the urea was that apparently it preserved the carotene very well. The word "apparently" is used advisedly, for although this result confirms work done elsewhere there is some question in our minds as to its validity. It is feared that the urea, or perhaps more correctly the type of fermentation induced by the high pH developed when urea was added, may have altered certain non-carotene pigments sufficiently to permit their estimation as carotene.

When a combination of urea and molasses was used a somewhat better product resulted. The pH was considerably lower, the volatile bases and butyric acid were much lower, and considerable lactic acid was formed.

The principal idea in using the urea was to increase the nitrogen content, and hence the potential protein level, of the silage. The molasses was added not only to act as a preservative but to furnish readily available energy for those types of microflora which might synthesize the urea into protein, or at least into intermediate nitrogenous compounds. That the idea did not work well in practice is evidenced not only by the unsatisfactory quality of the silage as already noted, but also by rather definite evidence that much of the urea was lost by leaching. The average nitrogen content of the leachings from the experimental silo for four years previously was 0.30 percent; when the urea was used it was nearly double that amount (0.56 percent).

Excellent silage resulted when 150 pounds or more of ground wheat was used. The pH was satisfactory (4.3), volatile bases were low, butyric acid was either low or absent, and there was a relatively high content of lactic acid. The silage had a mild, pleasing odor and was very palatable to the cows. The herdsman observed that it was the best quality silage he had fed in the eight years of experience with grass silage.

The biochemical studies mentioned last year have been continued. The outstanding conclusion from this phase of the work is that the kind of crop and the stage of maturity at which it is harvested are of more importance in determining the quality of silage than the preservative used. Preservatives are of some benefit under certain conditions; but wherever it is practicable to control moisture content by wilting the crop before storage, an excellent grade of silage can be made without the use of a preservative. The one disadvantage of wilting (or of letting the crop become more mature before cutting, which is another way of reducing moisture) is that the carotene losses are somewhat higher than where preservatives have been used.

**The Effect of Feeding Synthetic Thyroprotein to Milking Cows.** (J. G. Archibald.) This project, initiated in April, 1944, is being conducted in cooperation with Cerophyll Laboratories Inc. of Kansas City, and in collaboration with the State Department of Mental Health. Eighteen milking cows in the Holstein herd at the Medfield State Hospital are being used for the work. The objective is to ascertain the effects of feeding this synthetic hormone to milking cows for relatively long periods of time. It is already known that the feeding of it causes a definite positive response in milk secretion; the question which at once arises and which it is the aim of this project to help answer is: Is this positive stimulus lasting and how does it affect the cows in those respects other than milk production?



## DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

**Nitrification in Soils Containing Plant Residues of Varying Lignin Content.** (James E. Fuller, cooperating with the Agronomy Department.) This study was conducted on a sandy loam soil, characteristic of the Connecticut Valley tobacco lands in Massachusetts. The field was divided into six plots, and each plot into a sufficient number of strips to permit the planting of the several cover crops, which included tobacco, corn, artichoke, buckwheat, barley, rape, sudan, sorghum, oats, rye, wheat, millet, and sunflower. The plots were plowed as follows: two plots early, after the cover crops were well up; two in mid-season, after the crops were well developed but not hardened; and two at the end of the season, after the plant materials had matured and hardened.

The following season tobacco was planted over the whole field. Soil samples representing all of the strips on all six plots were collected early, before the tobacco was planted; in mid-season; and late, after the tobacco had been harvested.

Two series of laboratory studies were made of the nitrifying capacity of the soil: one in which dried blood (1 gm. per 100 gm. soil) was mixed with the soil, and a second in which ammonium sulfate (50 mgm. N per 100 gm. soil) was employed. Equal quantities of these mixtures were put into glass tumblers and water was added and maintained at optimum moisture content. The tumblers were allowed to stand at room temperature for four weeks, and then nitrate determinations were made (phenol-di-sulfonic acid method, A.O.A.C.).

The results of the analyses failed to indicate any relationship between the nitrifying capacity of the soil and the cover crops plowed under. Attempts to correlate the nitrification figures with the tobacco crop yields and indices also failed to show any demonstrable relationship. The only deduction that could be made was a general one: that matured and hardened plant residues plowed under late in the season apparently exerted a depressing effect on the nitrifying capacity of the soil as compared with the effects of the residues plowed under early and in mid-season.

**Bacteriological Studies of Rural Water Supplies.** (James E. Fuller.) In the routine bacteriological testing of rural water supplies in this laboratory, the coliform bacteria encountered are frequently classified as intermediates of the group: that is, they do not give the differential reactions of either the fecal type *Escherichia coli* or of *Aerobacter aerogenes* which is commonly encountered in soil. As a result, the interpretation of tests is often difficult. In the present study a number of these cultures have been tested by routine standard tests (lactose fermentation, Endo's agar, and "Imvic" reactions) over a temperature range extending from 37° to 46° C. (Eijkman test for *E. coli*). Results indicate that a majority of contaminated rural water supplies have received their contamination from surface wash rather than from sewage.

**Relation of Chloramine-Resistant Bacteria to Milk Supplies.** (James E. Fuller.) Preliminary work on this project has consisted of isolating and describing bacteria that have resisted chloramine (chlorine-ammonia) treatment as it is applied to the Amherst water supply. A number of false presumptive tests have been encountered in the water since the chloramine treatment was started. Results indicate that these false tests are caused by coliform bacteria that have been inactivated by long absence from their natural environment, combined with non-coliform bacteria. The relationship of these bacteria to milk supplies will be the next phase of the study.



**Bacteriological Study of Septic Tank Efficiency.** (James E. Fuller.) This project was intended to be a cooperative study with the Division of Engineering of the Massachusetts State Department of Health, with whom it originated. The purpose of the study was, and still is, to study the effect of different sewage retention periods on the bacterial and chemical quality of the effluent from septic tanks. A tank was constructed having three compartments. Sewage from one of the college dormitories was fed from a common receiving chamber into these compartments through orifices of such size as to provide three different retention periods for the sewage.

State Department of Health representatives designed and supervised construction of the installation, and its operation was originally the responsibility of Western Massachusetts District Engineering Office in Amherst. The design of the tank proved to be faulty, and the state engineer in charge entered the Army. The project then was taken over by the Experiment Station and assigned to the Bacteriology Department. Attempts to operate the tank satisfactorily proved futile, and the Army Air Corps cadets were removed from the college dormitory which supplied the sewage. As a result, the project was suspended until the dormitory is once more occupied to provide sewage. Meanwhile, plans are under way to redesign and reconstruct the tank in the effort to improve its operation. The future of the project depends on the effectiveness of the reconstruction, which is being supervised by the Engineering Department of the College, and upon the dormitory being occupied to provide an adequate supply of sewage.

**Recovery of Agar from Used Laboratory Media.** (James E. Fuller and John M. Woodward.) The purpose of this study was to develop a rapid and efficient method for recovery of agar that would be practical for small laboratory use. The method developed follows:

*Preparation.* Melt the used media and filter through a layer of cheesecloth. Put into beakers to solidify, in a refrigerator if haste is necessary, or otherwise at room temperature. Cut the solid agar into small bits and then force it through a wire screen  $\frac{1}{4}$  or  $\frac{3}{8}$  inch mesh. Put into a cheesecloth bag for washing.

*Washing.* (1) If running water can be used, the time required for washing the agar may be substantially reduced. Suspend the cheesecloth bag in a container deep enough to permit complete immersion of the agar. Run water gently and continuously through the container for about 6 hours. By that time the agar will be clarified, and the Fehling's and biuret tests will be negative. (2) If it is not practicable to use running water, the bag of agar may be suspended in 3 liters of water for each liter of agar. Start the washing in the morning and change the water in the evening, the next morning, and the next evening. A half day of washing the third day should complete the process satisfactorily. Either method of washing should recover about 90 percent of the theoretical yield of agar.

*Drying.* After the agar has been washed, suspend the bag to permit drainage of surplus water, then spread the agar in a thin layer in a shallow pan and dry at 45° C. The dried agar may be used in the same way as commercial agar.

The recovery of agar from media containing dyes is not recommended because the bleaching process is tedious and is apt to impair the gelling property of the agar.

**The Effect of Physical and Chemical Agents on Plate Counts.** (James E. Fuller and Thomas Sparkes.) One of the limitations of bacteriological plating technique is the difficulty of breaking up clumps of bacteria. In this study both market milk and sterile milk artificially inoculated were employed. Rates of shaking were 200, 400, and 900 per minute, with and without broken glass. Two and five minute periods were employed with each rate. Counts were not

substantially increased over those obtained by the "Standard Methods" procedure. Several commercial wetting agents were employed, as well as Ivory soap. None gave sufficiently improved results to justify their use in routine plating.

**Vitamin and Amino-acid Requirements of Non-pyogenic Streptococci.** (James E. Fuller and Ruthe Galler.) Certain of the non-pyogenic streptococci from the mouth or intestines are considered of importance as indicators of pollution. All of these types may be found in swimming pool water, and those from the mouth have been suggested as logical indicators of unsatisfactory cleaning of eating and drinking utensils. There are no simple direct methods of identifying these organisms and this study was made in the effort to develop some such method.

Representative non-pyogenic streptococci were cultivated in a synthetic medium. Vitamins (riboflavin, pantothenic acid, and pyridoxine) and amino acids (tryptophane, tyrosine, lysine, arginine, methionine, valine, and glutamic acid) were incorporated in the medium in various combinations. Each organism required all of the amino acids and all of the vitamins employed. It was not possible to substitute para-aminobenzoic acid for any of the vitamins mentioned.

**Laboratory Service, December 1, 1942, to June 30, 1944.** (James E. Fuller.)

Milk, bacteria counts.....	297
Ice cream, bacteria counts.....	115
Water, bacteriological tests.....	191
Total.....	603

## DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

**Diseases of Trees in Massachusetts.** (M. A. McKenzie and A. Vincent Osmun.)

*The Dutch Elm Disease Problem.* *Ceratostomella ulmi* (Schwarz) Buisman, the causal fungus of the Dutch elm disease, has been isolated from 17 trees in eight municipalities in Massachusetts, and to date (June 1944) affected trees have been removed and burned as follows:

	1941	1942	1943	1944
Alford.....	1			
Egremont.....		3	2	2
Great Barrington.....		1	1	1
Mount Washington.....				1
Pittsfield.....				1
Sheffield.....		1		1
Westfield.....		1		
West Stockbridge.....			1	

Breakage of trees caused by ice storms in December 1942 and January 1943 contributed to the increase in elm material suitable as breeding places for the principal carrier of the disease, a bark beetle (*Scolytus multistriatus* Marsh.). The beetle is now known to be present generally in Massachusetts east of Worcester County and has been reported widely in Berkshire County and Hampden County in addition to six towns in Hampshire County.

In an attempt to reduce the quantity of elm items which might contribute to the spread of this disease, municipal tree departments cooperated in a program

for treatment or disposition of the elm material involved. Timely selective treatment is a most important consideration in the control of the disease, and the Massachusetts Tree Wardens' and Foresters' Association, together with Local Moth Superintendents, have planned regional meetings throughout Massachusetts for the summer to formulate further plans for Dutch elm disease control throughout the State.

At the present time, surveys and recommendations for control practices are made by the Experiment Station in regions where the disease occurs, and sanitation practices are performed by the Massachusetts Department of Agriculture and the municipalities and property owners concerned. Elm material found to be infested or suitable for infestation by carrier beetles should be utilized as fuel or debarked by June 1 in any year, as a means of checking the increase in the population of the vectors of the disease. Tree wardens, foresters, arborists, fire wardens, highway departments, state departments, and public utilities have materially aided in this practical method of protecting disease-free elms, and other means of treatment are being explored constantly in cooperation with the Department of Entomology.

*Other Tree Problems.* Fifty-six diseases of thirty-two species of trees including eight diseases of elm were identified from approximately 320 specimens and inquiries received during the year. The *Cephalosporium* wilt of elm was reported from one additional municipality in which the disease has been found in Massachusetts. *Verticillium* sp. was isolated from several species of woody plants, and one specimen was collected in a municipality from which the writers had no previous report of the fungus.

Soon after the leaves developed in 1943, wilting of foliage occurred on maple trees in all parts of the State. In some cases trees died, especially Norway maples, while individual branches commonly were affected also on sugar maple. Several factors were involved, but the only fungus isolated which is known to be a primary cause of disease was *Verticillium* sp. Field studies will be continued during 1944 in locations where affected trees were reported.

Rust of red, green, and possibly other species of ash trees, caused by *Puccinia peridermiospora* (Ell. & Tr.) Arth., was particularly prevalent in the coastal regions of Massachusetts during early summer. Because of the large number of inquiries received concerning this disease, a circular was prepared to facilitate the handling of requests.

An unusually large number of shade and ornamental trees, particularly evergreens, died or failed to produce satisfactory foliage in 1944. Contributing factors were presumably the drouth of the previous summer, deep freezing of the ground in a relatively dry condition in the absence of snow cover in winter, bright sunlight of winter, and drying winds. Previous to the appearance of widespread injury, recommendations for maintaining street trees in a safe condition and for pruning diseased parts of trees, treatment of tree wounds, sanitation practices, and the use of disease-resistant trees were prepared for municipal tree departments. More recently, a report on tree damage in association with winter conditions has been prepared.

Foliage of trees throughout the State, in common with many food plants, suffered from the effects of the heavy frost on May 19 and 20, 1944. In some cases all leaves on trees were destroyed, while all degrees of leaf injury from slight to relatively extensive were also noted. Among the more common trees, sycamores, oaks, beeches, sumacs, walnuts, butternuts, hickories, maples, alders, and elms, in order of listing, were injured more or less significantly; but doubtless many other woody plants with soft growth were also affected.



A number of inquiries concerning wood-destroying fungi have been received during the past year. Probably this is a result of the nonavailability of wood and wood products for replacement purposes. In most cases the use of treated wood could have prevented fungus damage, but treated woods as well as materials for treatment, are not always obtainable.

Municipalities were greatly handicapped in carrying out tree disease control programs because of the shortage of manpower. A program providing for the treatment of trees by part-time workers was suggested to help meet the emergency and has proved workable. In an effort to get cooperation on the part of the public in municipal tree protection programs, public utilities arranged for the distribution of cards announcing Massachusetts Agricultural Experiment Station Bulletin 397 entitled "A Civilian Program for Tree Protection." Details of the operation of the program were included in a report. The response by the public was extremely gratifying, and municipalities and utilities have requested that further study be given to the matter of recommending methods for educating the public in street tree problems.

**Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modification of Environment.** (W. L. Doran.) In cooperation with John S. Bailey of the Department of Pomology, especial attention has been given to the propagation of high-bush blueberry and beach plum by softwood cuttings, and papers have been published on those subjects.<sup>1,2</sup> Cuttings of blueberry rooted best if taken 2 to 3 weeks before the first fruits ripened, treated with indolebutyric acid or indolepropionic acid, and set in sand-sphagnum peat. The method is a timesaver as compared with the former use of hardwood cuttings. Beach plum cuttings, treated with indolebutyric acid, gave best results if taken when fruits were about one-eighth inch in diameter; and by no method previously described has the beach plum been so rapidly and readily propagated. Early July cuttings of Myrobalan plum rooted well after treatment with naphthaleneacetic acid.

Manetti stock, for grafting roses, is not now available in sufficient quantities and at the request of a large grower of greenhouse roses work on their propagation by cuttings was begun. Two-bud cuttings of rose rooted well in sand-sedge peat after treatment with mixtures of a Hormodin and the fungicides Arasan or Spergon. These fungicides added to indolebutyric acid in talc caused no injury to cuttings of the several species with which they were used. In work with Lawrence Southwick of the Department of Pomology, such use of Spergon prolonged the life of unrooted cuttings of apple. Cuttings of hemlock rooted better if taken from the north side of a tree, better and more rapidly if treated with indolebutyric acid solution followed by powder dip treatment with indolebutyric acid in talc plus Spergon.

Rooted white pine cuttings grew about 5 inches, erect and symmetrical, in their second year.

Cuttings of most of the woody plants used rooted better in sand-sedge peat than in sand-sphagnum peat.

Late fall cuttings of *Franklinia*, *Tripterygium* and *Marsdenia* rooted well without treatment; but the rooting of similar cuttings of *Orixa japonica*, *Colutea media*, *Indigofera amblyantha* and a mulberry was improved by treatment with root-inducing substances.

<sup>1</sup> Doran, W. L. and Bailey, J. S. Propagation of high-bush blueberry by softwood cuttings. Mass. Agr. Expt. Sta. Bul. 410. 1943.

<sup>2</sup> Doran, W. L. and Bailey, J. S. A second note on the propagation of beach plum by softwood cuttings. Amer. Nurseryman 78:87-8. 1943. (Mass. Sta. Contrib. 496.)



**Study of Diseases of Plants Caused by Soil-Infesting Organisms, with Particular Attention to Control Measures.** (W. L. Doran.) Especial attention has been paid this year to investigations of the use of urea, dichromates, sodium nitrate, formaldehyde, and other materials as soil fungicides for the control of damping-off and for the control of onion smut; also to the control of damping-off of vegetable seedlings other than by the use of soil fungicides and to certain seed treatments for use with vegetables.

The application of a very dilute solution of formaldehyde to soil immediately after seeding is a safe, convenient, and simple method for the prevention of post-emergence damping-off. At the request of the Du Pont Company, an article was written on the subject and published in their *Agricultural News Letter*.<sup>1</sup> Such treatment with formaldehyde is readily combined with subirrigation immediately after seeding, and L. H. Jones and the writer published on that method.<sup>2</sup>

In the absence of any chemical soil treatment against damping-off fungi, stands of vegetable seedlings under glass may be improved by postponing the first watering. Stands of eight commonly grown vegetables were better when soil was not watered until three to five days after seeding.

In work with Thomas Sproston, Jr., on onion smut, soil treatments with sodium nitrite, Fermate, or urea markedly reduced the severity of the disease; but urea, unless applied to soil long before seeding, may interfere with germination or growth.

Urea proved to be a safe and effective soil fungicide with peas when used on a limed sandy soil (0.2 milli-equivalents of exchangeable H per 100 gm. soil), but it gave poor results in soils which were unlimed or not sandy.

Fermate, applied to soil immediately before seeding, or Elgetol, ammonium dichromate, or potassium chromate, applied to soil immediately after seeding, gave good and safe control of damping-off of certain vegetables.

As seed treatments for vegetables, ammonium, potassium, or sodium dichromate, diluted with graphite, gave good results, comparable to those obtained with new proprietaries.

Seed treatments of beet with Arasan, of cucumber with Semesan, and of lettuce with Spergon prevented pre-emergence damping-off equally well whether soil was first watered 1, 2, 3, 4, or 5 days after seeding and whether the temperature of the water applied was 40° or 100°F.

Soaking seeds of eight commonly grown vegetables in water for various lengths of time immediately before seeding did not sufficiently hasten germination or emergence to affect either pre- or post-emergence damping-off.

**Effect of Soil Temperature on Leaf Pattern of Tobacco Mosaic Virus.** (L. H. Jones.) Seedlings of Havana Seed tobacco were established at a soil temperature of 70° F. One fourth of the plants were inoculated with a mosaic virus, and 24 hours later the soil temperatures were altered to establish a range from 50° to 95° at 5-degree intervals. The inoculated plants at all temperatures showed the typical pattern of mosaic infection by the 13th day; but on the plants at 90° and 95°, terminal growth gradually stopped and a rosette of frenched leaves appeared at the top, while at temperatures below 90° the common mosaic pattern continued. These results were confirmed when the pots at 95° were interchanged with those at 50° soil temperature.

<sup>1</sup> Doran, W. L. Soil treated with formaldehyde after seeding to control damping-off. *Agr. News Letter of E. I. du Pont de Nemours and Co.* 11:3:47-49. 1943.

<sup>2</sup> Jones, L. H. and Doran, W. L. A practical method for sterilization and subirrigation of soil in flats. *Flor. Exchange* 100:22:9, 11. 1943. (*Mass. Sta. Contrib.* 482.)

This preliminary work indicates that frenching of tobacco leaves inoculated with a mosaic virus may be induced by a high soil temperature; or else there was associated with the mosaic virus a frenching virus, the effects of which are apparent only at soil temperatures of 90° and above.

Soil temperature had a marked effect on the development of uninoculated tobacco plants. Growth was slow at temperatures below 65°, and increasingly rapid at the higher temperatures. The uninoculated plants showed no evidence of frenching at any of the temperatures.

**Effect of Soil Temperature on Certain Forage Grasses.** (L. H. Jones.) Seedlings of brome grass (*Bromus inermis* Leyss.), meadow fescue (*Festuca elatior* L.), perennial rye grass (*Lolium perenne* L.), and timothy (*Phleum pratense* L.) were established at a soil temperature of 65° F., which after 18 days was altered to produce a range of temperatures from 50° to 90° at 10-degree intervals. Fescue, rye, and timothy, according to values of growth and dry matter produced, had an optimum soil temperature of 70°; brome grass did best at 90° and poorest at 50°; rye and timothy did well at 50° and poorly at 90°; and fescue did well through the whole range of temperatures employed.

**Creosote Injury to Plants.** (L. H. Jones.) Wherever creosote fumes are evolved in confined spaces, such as cold frames, there is certain to be serious injury to plants. Creosoted lumber covered with soil has not been harmful to seed germination or the growing plant in any of the experiments. However, when the creosoted wood was above the soil line and consequently above leaves, as in a seeded flat, injury occurred, appearing first as a rolling of the leaves, usually upward and inward. Continuous exposure to the fumes eventually killed the plants. Air temperature and sunlight intensity are probably contributing factors, not only in causing an evolution of creosote fumes, but also in making the plants more susceptible to injury from the fumes.

Creosoted paper used flat on the soil as a collar for the protection of cabbages against maggots did not produce injury unless there was poor air drainage or failure to remove frost protectors in the presence of sunlight. If the stems are soft when the maggot protectors are applied, it is possible that the plants can be harmed by creosote coming in contact with such tender tissue.

If creosote fumes are evolved in a sunlit chamber, types of injury similar to those obtained with illuminating gas result. With tomato plants epinasty, early senility, and abscission were frequent results of exposure to fumes of creosote for a limited time. Longer exposures caused immediate leaf death more often to leaves of medium age than to the oldest or youngest leaves.

Weathering of treated wood may reduce the intensity of the injury, but cabbage plants showed considerable injury from wood known to have been creosoted six years previously.

**Causes and Control of Decay of Squash in Storage.** (E. F. Guba, Waltham.) In previous work with gourds, less shrinkage from decay after harvest occurred when the plants were protected with a fungicide during their growing period in the field. This year the effort was applied to Blue Hubbard squash. The control plots gave as good yields of mature squash and as low a percentage of immature infected squash as did the plots dusted or sprayed with fungicides.

Decay found among the small immature squashes was essentially due to *Choanephora cucurbitarum* (Bark & Rav.) Thax. brown rot, and *Macrosporium cucumerinum* E. & E. black spot rot. Some bacterial wilt rot, due to *Erwinia tracheiphila* was evident among the mature squash at harvest.

**Control of Greenhouse Vegetable Diseases.** (E. F. Guba, Waltham.) With the objective of developing a tomato of desirable commercial type, immune to leaf mold and yielding fruit weighing  $3\frac{1}{2}$  to 5 ounces each, the Bay State tomato has been hybridized with various types which are immune to leaf mold. In the  $F_2$  generation, segregations appeared for various degrees of susceptibility and for immunity. The population of totally immune plants varied from 72 to 86 percent; and two of the crosses produced tomatoes which averaged  $2\frac{1}{2}$  to  $3\frac{1}{2}$  and  $2\frac{1}{3}$  to  $2\frac{3}{4}$  ounces each, indicating that the objective may soon be realized.

**Disease Resistance and Heredity of Carnations.** (E. F. Guba cooperating with H. E. White, Waltham.) Project has been suspended for the duration of the war, projects on food production being considered more important.

**Interrelation of Wettable Sulfur, Lead Arsenate and Lime in Apple Spraying.** (Departments of Botany, Chemistry, Entomology and Pomology cooperating.) This project is intended to add to our knowledge of insect and disease control and spray injury. On this basis special consideration was given to tenacity of sulfur, particle size of sulfur, scab and plum curculio control and russet injury. As in the past, detailed reports of the work at Amherst and Waltham are compiled and submitted to the departments involved.

**Miscellaneous Studies.** (E. F. Guba and E. V. Seeler, Jr., Waltham.)

**Control of Cabbage Club Root with Chlorpicrin.** A plot of ground badly contaminated with cabbage club root fungus was treated with chlorpicrin, 25 pounds to 1000 square feet, two weeks before it was planted to clean cabbage plants from steam-sterilized soil. Growth of the plants was generally poor—in the untreated plot because of club root, and in the treated plot because of club root and chlorpicrin gas persisting in the soil long after application. Although root infection was less in the treated plot, more and better heads developed where the soil had not been treated. This is in line with results of previous tests of various chemicals which have been advocated for controlling club root. Our results over the years show nothing significant in favor of chemicals applied to the field in advance of planting; and we are led to accept the use of new or uncontaminated land as the only practical method of controlling the club root disease under our conditions.

**Cooperative Vegetable Seed Treatment Demonstration.** These demonstrations were sponsored by the American Phytopathological Society in cooperation with the states to study the efficacy of various newer chemical seed treatments, and to standardize the pre-treatment of seeds for the control of seed decay and damping-off. The results of the trials in the different states will be summarized and published in the Plant Disease Reporter, U. S. Department of Agriculture. The best chemical treatments for each vegetable type considered at Waltham, representing the mean of five replicates, are as follows:

Bean (Lima) . . . . .	Spergon, .20 percent by weight
Bean (Snap) . . . . .	Fermate, .20 percent by weight
Beet . . . . .	Yellow Cuprous Oxide, 2.0 percent by weight
Carrot . . . . .	U. S. R. n. 604, 1.5 percent by weight
Corn (Sweet) . . . . .	Arasan, .18 percent by weight
Spinach . . . . .	Fermate, .25 percent by weight
Onion . . . . .	Fermate (excess dosage)
Pea . . . . .	Spergon, .168 percent; Thiosan, .168 and .335 percent



*Studies on the Identity and Control of a Stilbaceous Mold in Gas Purifying Sponge.* Our attention was invited to a compact moldy growth in sponge layers of iron oxide and wood shavings in the gas purifying boxes at the Everett Plant of the Boston Consolidated Gas Company. The sealing of the sponge impeded the flow of gas and interfered with its purification. The fungus was determined by Dr. David Linder, Harvard University, as *Sporocybe Borzinii* Goidanich, which is the imperfect stage of *Petriella Lindforsii* Curzi. What is known of the fungus would indicate that it is indigenous to wood. A few samples of wood shavings from stock piles were examined in a search for the *Sporocybe* fungus but none of it was found. Information has been obtained on the temperature and pH relations of the fungus and upon the lethal action of heat and formaldehyde, which will be compiled for publication.

## DEPARTMENT OF CHEMISTRY

Walter S. Ritchie in Charge

**Chemical Investigation of the Onion.** (Emmett Bennett.) An analysis of the tops and bulbs of the Ebenezer onion has been made on samples representing various stages of growth and on those cultured in distilled water in sunshine-darkness and in darkness. In general, the trends of some of the constituents of the Ebenezer onion indicate that the cultural period may be divided into two parts. The first part, consisting of about two-thirds of the total growing period, is spent in developing a top of great synthesizing powers. The second is characterized by a rapid gain in weight by the entire plant, followed by a more or less complete removal of solutes to the bulb. This period is initiated by a softening of the neck which occurs because new leaves are not being formed. As a result of these physiological processes it may be said in general that in the tops the content of total ash and of all the nitrogen fractions, determined quantitatively, decreased with maturity accompanied by an increase of soluble sugars until signs of maturity develop; in the bulbs the content of all constituents increased.

The chief points of interest in these trends are:

1. That the amides accumulate in the bulbs, especially during the second period.
2. That the total nitrogen of the bulb at maturity is soluble to the extent of about 80 percent.
3. That reduction of nitrates appears to take place in the bulb.

In comparison with the normal, the chief changes which occurred in the onions in artificial cultures were:

1. That transportation of solutes from the tops to the bulbs occurred very slowly during 139 hours in complete darkness.
2. That complete darkness caused a more extensive utilization of the soluble carbohydrates than did sunshine-darkness.

A compound believed to be pyruvic acid has been isolated and characterized. So far as we are aware pyruvic acid has never been isolated from any of the higher plants. The crystals of the 2, 4-dinitrophenylhydrazone were greenish yellow diamond-shaped plates. The poles of the longer axis were pointed, while those of the shorter axis were curved or rounded. The compound melted at 241°C. and contained 20.20 percent nitrogen.

**Phosphorus Compounds in Certain Vegetables.** (Emmett Bennett.) A fractionation was made of the phosphorus compounds of 11 different vegetables



into inorganic, organic, resistant esters, phytin, phospholipid and phosphoprotein phosphorus. The results indicate that the bulk of the phosphorus is in the inorganic form; that the organic fraction may be composed of widely varying amounts of resistant esters, and phosphoproteins and phospholipids; and that phytin was absent in all cases. Therefore, there are no unavailable forms of phosphorus in these vegetables.

**The Chemical Investigations of Hemicelluloses.** (Emmett Bennett.) The numerical values of the soluble sugars, pectic compounds, and hemicelluloses are usually not given as such but are included in the nitrogen-free extract value. Data obtained from 14 common vegetables indicate that the percentage content of soluble sugars may range from 4 to 51 percent of the dry matter or about 12 to 66 percent of the nitrogen-free extract. Pectic materials and hemicelluloses collectively may constitute from 5 to 19 percent of the dry matter or from 11 to 52 percent of the nitrogen-free extract. These data indicate that the amount of soluble sugars, pectic compounds, and hemicelluloses varies with the species, and that the numerical value of the nitrogen-free extract gives little information regarding the relative amounts of these fractions.

Hemicelluloses from corn cobs and rye straw have been isolated and purified for work designed to indicate the chemical nature of these substances.

**Factors Affecting the Riboflavin Content of Milk.** (Arthur D. Holmes.) Although it is generally accepted that milk is one of the rich natural sources of riboflavin, and many investigators have reported studies on the subject, there are still many phases about which knowledge is incomplete or lacking. These studies were made for the purpose of filling some of these gaps. The milk used was produced by the college herd of Ayrshire, Guernsey, Holstein, Jersey, and Shorthorn cows. The large number involved would eliminate any influence of individual characteristics of the cows. Since farm herds in this locality are made up of more than one breed of cows, and since the management and feeding of the cows were similar to those of modern, local dairy farms, the results should be applicable to commercially produced milk, in this region at least.

*The Effect of Pasteurization on Riboflavin Content.* (Arthur D. Holmes.) Winter milk (December and January) was assayed before and after pasteurization. The raw milk contained an average of 1.46 mg. of riboflavin per liter; after pasteurization, the milk contained 1.43 mg. per liter. Accordingly, the consumer can be assured that, from a practical dietetic standpoint, he will obtain essentially as much riboflavin from milk recently pasteurized (under the conditions of this study) as he would obtain from the same milk just before pasteurization.

*The Uniformity of the Riboflavin Content of Milk Produced under Standardized Conditions.* (Arthur D. Holmes and Julia O. Holmes.) The riboflavin content of milk, as reported in the literature, is extremely variable, with extremes of 0.53 and 7.8 mg. per liter. At intervals during the four months, December to March, inclusive, 80 samples of milk were taken and assayed for riboflavin. The average amount of riboflavin per liter of milk was 1.45 mg. for December, 1.50 mg. for January, 1.49 mg. for February, and 1.46 mg. for March. These results seem to justify the conclusion that it is possible to standardize the feeding and management conditions for a dairy herd sufficiently so that milk of relatively uniform riboflavin content may be produced for considerable periods of time. This would be true particularly for dairy herds that are stall fed continuously year after year. Such a source of milk would be especially helpful to the physician who desired for his patients milk with a dependable, uniform riboflavin content.

*The Ratio of Ascorbic Acid, Riboflavin, and Thiamine in Raw and Pasteurized Milk.* (Arthur D. Holmes, Carleton P. Jones, Anne W. Wertz, and John W. Kuzmeski.) While a considerable body of data is available concerning the ascorbic acid, riboflavin, and thiamine content of milk, not a single report was found of the assay of a milk for all three of these vitamins. Accordingly, 32 samples of milk produced by the college herd were assayed before and after pasteurization. The average values obtained were ascorbic acid 19.7 mg., riboflavin 1.51 mg., and thiamine 0.33 mg. per liter of raw milk; ascorbic acid 15.9 mg., riboflavin 1.48 mg., and thiamine 0.30 mg. per liter of the same milk after pasteurization.

The ratios of riboflavin, ascorbic acid, and thiamine were computed for both the raw and the pasteurized milk. The raw milk contained 4.6 times as much riboflavin as thiamine 13.1 times as much ascorbic acid as riboflavin, and 59.8 times as much ascorbic acid as thiamine; the pasteurized milk 4.9 times as much riboflavin as thiamine, 11.0 times as much ascorbic acid as riboflavin, and 53.8 times as much ascorbic acid as thiamine.

*Ascorbic Acid, Riboflavin, and Thiamine Content of Milk as Influenced by the Ration.* (Arthur D. Holmes, Carleton P. Jones, and Anne Wertz.) It is generally agreed that, under normal conditions, changing the cow's ration does not cause any significant changes in the protein, fat, and mineral composition of the milk. There is, however, a lack of agreement regarding the effect of changing a cow's ration upon the vitamin content of her milk. Since it is generally believed that young, rapidly growing grass is particularly rich in vitamins, this study was made during the interval while the cows were being transferred from the winter ration to green grass pasture ration.

When the cows were changed from the winter ration to an early pasture of rapidly growing grass, the volume of milk produced increased; the ascorbic acid content of the milk decreased from 20.3 mg. to 19.1 mg. per liter; the riboflavin decreased from 1.43 mg. to 1.26 mg. per liter; but there was no change in the thiamine content.

*Effect of High-Temperature, Short-Time Pasteurization on the Ascorbic Acid, Riboflavin, and Thiamine Content of Milk.* (Arthur D. Holmes, Harry G. Lindquist, Carleton P. Jones, and Anne W. Wertz.) Twenty lots of milk produced by the college herd were pasteurized, with an Electropure pasteurizer, for 22 seconds at temperatures ranging from 161° to 181°F. Samples of the milk taken just before and immediately following pasteurization were assayed for ascorbic acid, riboflavin, and thiamine. The average values obtained were 16.4 mg. per liter of ascorbic acid for the raw and 16.6 mg. for the pasteurized milk; 1.50 mg. of riboflavin for the raw and 1.50 mg. per liter for the pasteurized milk; and .36 mg. of thiamine for the raw and .35 mg. per liter for the pasteurized milk. Hence, considered from a practical standpoint, milk pasteurized by this type of high-temperature, short-time procedure has as satisfactory ascorbic acid, riboflavin, and thiamine content as before pasteurization. In contrast, there were significant vitamin losses when milk was pasteurized at 145°F. for thirty minutes.

*Ascorbic Acid, Riboflavin, and Thiamine Content of Chocolate Milk.* (Arthur D. Holmes, Carleton P. Jones, Anne W. Wertz, and W. S. Mueller.) The term chocolate milk is very misleading since this product is very frequently made with cocoa. In this study both the American-process and the Dutch-process (alkali) cocoa were used.

Sixteen samples of chocolate milk were prepared by mixing 30 cc. of cocoa syrup and 240 cc. of freshly pasteurized milk. The pasteurized milk contained

16.6 mg. of ascorbic acid, 1.56 mg. of riboflavin, and .33 mg. of thiamine per liter. The American-process chocolate milk contained 15.4 mg. of ascorbic acid, 1.50 mg. of riboflavin, and .31 mg. of thiamine per liter; and the Dutch-process chocolate milk contained 11.5 mg. of ascorbic acid, 1.37 mg. of riboflavin, and .25 mg. of thiamine per liter. From a practical standpoint, these results indicate that chocolate milk made with American-process cocoa had essentially the same vitamin value as the pasteurized milk but the chocolate milk made with Dutch-process cocoa contained much less ascorbic acid, riboflavin, and thiamine. Since these results were obtained from assays made as soon as the chocolate milk was compounded they may not apply to chocolate milk that has been stored for varying periods of time before being consumed.

**The Ascorbic Acid Content of Late-Winter Tomatoes.** (Arthur D. Holmes, Carleton P. Jones, and Walter S. Ritchie.) The tomato is frequently listed as one of the richest vegetable sources of ascorbic acid (vitamin C), field-grown, fully ripened, vine-matured, summer tomatoes containing about 25 mg. of ascorbic acid per 100 grams. However, during the late winter and early spring months one finds on the market tomatoes that in neither color, taste, nor physical appearance compare in quality with the summer tomatoes. This study was concerned with the value of these late-winter tomatoes as a source of ascorbic acid.

The tomatoes were purchased from local stores in retail packages or by the pound, just as a homemaker would purchase them for home use. The results of 58 assays showed that average late-winter tomatoes contain 8.8 mg. of ascorbic acid per 100 grams. In computing the vitamin C value of a diet containing late-winter tomatoes, therefore, one should not assign to them more than one-third the ascorbic acid value ordinarily used for fully ripe, summer tomatoes.

**Riboflavin Content of Immature Massachusetts Lettuce.** (Arthur D. Holmes.) The lettuce used in this study was produced by the Agronomy Department under growing conditions quite typical for this locality.

The immature Boston head lettuce was picked during a three-weeks' period just before it began to form heads. At this stage all the leaves were spread out and exposed to light and sunshine. The plants were pulled from the ground early in the morning. The entire leafy portion of the plant except the lower mid-ribs was used and the assays were started within twenty minutes after the plant was taken from the ground, a condition quite different from that for lettuce purchased in the store. The riboflavin content of the 17 samples varied from 0.105 mg. to 0.155 mg. with an average of 0.124 mg. per 100 gm. These results show that immature Boston head lettuce eaten shortly after it is picked is a good vegetable source of riboflavin, and the evidence accumulated indicates that farmers and victory gardeners might well begin to consume lettuce before it reaches the heading stage.

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## CONTROL SERVICES

Philip H. Smith in Charge

The fertilizer, feed, seed and dairy laws are administered as one service and the operations of each of these, with the exception of the dairy law, are completely reported in annual bulletins issued for that purpose.

Besides the regular control activities the laboratory, through its staff, co-operates liberally on numerous research projects active in other departments and also performs many analytical and testing services for State institutions and for



private citizens who, because of the nature of their problems, deserve this consideration.

Under the dairy law 8,834 pieces of Babcock glassware were tested and 102 Certificates of Proficiency were issued during the one and one-half years ending June 30, 1944.

The enlarged emphasis on the vitamin values of all feeds, and commercial feeds in particular, and the increased interest in the mineral content of poultry mash and in the protein quality of meat and fish products used for feed demands continual expansion of the analytical service in those fields.

Restrictions in the use of certain materials and the scarcity or entire absence of others have made complete compliance with the feed and fertilizer laws difficult. The trade on the whole are to be commended for the attempt they are making.

War gardens have augmented the demands made upon the Seed Laboratory for checking of vegetable seeds. This additional work has been handled without an increase in staff partly due to the fact that the laboratory has been able to secure new supplies and equipment which not only facilitate the work but also bring methods and procedure more nearly up to date.

Two members of the Control Staff are on military leave. The positions have been temporarily filled.

## THE CRANBERRY STATION

East Wareham, Massachusetts

H. J. Franklin in Charge

**Weather Studies.** (H. J. Franklin, H. F. Bergman, and N. E. Stevens.) The various relations of the weather to cranberry culture were given very extensive attention during the year. Most of these studies have been followed over a long term of years and some of them were finished and the results published in Bulletin 402. Studies of the relations of the weather to cranberry yields are being continued.

### Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.)

**Hill Fireworm (*Tasca finitella* (Walker)).** The infestation of this pest on the Burrage bog, mentioned in previous reports,<sup>1</sup> continued to be extensive in 1943. The bog was completely flooded on June 4 for 36 hours to stop the egg-laying of the moths and again on June 13 for 36 hours to kill the worms that had hatched. In spite of these treatments, the worms became very abundant among the vines. Apparently many of the moths had escaped the first flooding by flying ashore and then returned to lay more eggs on the bog.

Eggs of this insect, laid in confinement on June 4, hatched on June 9, only 5 to 6 days after they were laid. When first laid, the eggs were oblong-oval and yellow or reddish yellow, the largest of them being very nearly a millimeter long. They became bright crimson within a day and a half and remained so up to within half a day of their hatching.

The newly hatched worms had blackish heads and reddish bodies.

As in the two previous years, the worms did most of their work well down among the vines in a zone 3 to 6 inches above the bog sand.

**Cranberry Spittle Insect (*Clastoptera*).** The nymphs were first found in their spittle on June 7. Flooding for 24 hours as soon as occasional flowers have opened proved to be a very effective treatment on a number of bogs.

<sup>1</sup> Mass. Agr. Expt. Sta. Bul. 388:37, 1942; and 398:26, 1943.



*Spotted Fireworm (Cacoecia parallela (Rob.))*. The bog in Marion mentioned in last year's report<sup>2</sup> was seriously attacked by this insect again this year, the last of May. The worms were completely killed out by flooding for 30 hours on June 5 and 6. The winter water had been removed from this bog on May 10.

*Cranberry Scale (A. oxycoccus Woglum)*. A rather severe infestation of this species on a part of the large bog of the Nantucket Cranberry Company was treated very successfully in the early spring, after the removal of the winter flood, with the following sprays, each used at the rate of about 500 gallons an acre<sup>3</sup>: (1) Dry lime-sulfur, 16 pounds in 100 gallons of water; (2) Pratts Spr Cream, 1 gallon in 100 gallons of water.

Nearly all the scales were killed by these sprays. The lime-sulfur did almost no harm to either the cranberry vines or their crop. The oil spray stunted the berries somewhat and retarded the new vine growth rather noticeably.

*Grape Anomala (Anomala lucicola Fab.)*. Grubs of this species were sent to the Japanese and Asiatic beetle laboratory at Moorestown, New Jersey, to have their susceptibility to the milky disease organism determined. Mr. C. H. Hadley, in charge of the laboratory, reported the following results.

Further reference is made to earlier correspondence, particularly Dr. Hawley's letter to you of January 18, regarding the susceptibility of *Anomala lucicola* to type A milky disease. Our tests to determine the susceptibility of this species to infection by type A milky disease have now been completed, and you will be interested in the results.

The grubs used in the test were those which you kindly sent us late in November 1942. Of the surviving larvae of that shipment, 10 were inoculated by direct injection with spores of the type A milky disease, *Bacillus popilliae*. Five of these larvae developed typical type A vegetative forms and spores. After 10 days incubation at 86°F. the infected larvae differed but little in macroscopic appearance from the noninfected specimens which had been injected, the typical chalky-white appearance, characteristic of milky diseased Japanese beetle larvae, not being evident.

Twenty of the healthy larvae were exposed to infection in soil in which the concentration of type A milky disease spores was 2 billion spores per kilogram of soil. These larvae were incubated at a temperature of 86°F., examined at frequent intervals, and held until all the larvae had pupated or died. After 25 days incubation, each was examined microscopically for the presence of milky disease. In no case was there evidence of positive infection.

These tests would seem to indicate that this species possesses a relatively high degree of natural immunity to type A milky disease. Of course the number of larvae employed in the test was rather limited, so that probably it should not be said that this species is completely immune to field infection from type A disease. However, in view of the fact that direct injection of spores known to be viable produced only 50 percent infection under incubation conditions known to be very nearly optimum for the development of the disease, it may be assumed that this species is certainly less susceptible to the disease than Japanese beetle larvae, and is probably rather highly immune under ordinary field conditions.

Specimens of the infected larvae which did react positively were forwarded to the Division of Insect Identification of the Bureau and identified by Dr. Boving as *Anomala lucicola*. His identification confirms that given by you in your letter of January 18, 1943.

Incidentally, Dr. Hawley's letter to you of January 8 is now known to be incorrect in so far as the susceptibility of the larvae to feeding in infected soil is concerned. At that time several of the larvae in the feeding test were suspected of being infected with milky disease. Later, however, when blood smears of the suspected larvae were examined microscopically it was found that these larvae were not infected with milky disease.

<sup>2</sup> Mass. Agr. Expt. Sta. Bul. 398:26, 1943.

<sup>3</sup> Information from Marland Rounseville, the foreman.

*Prevalence of Cranberry Insects in 1943.*

1. Bumblebees and honeybees rather abundant nearly everywhere on Massachusetts bogs during the cranberry flowering; somewhat less abundant than in 1942.
2. Cranberry fruit worm (*Mineola*) much more prevalent than for quite a number of years.
3. Infestation by gypsy moth (*Porthetria*) rather light in Plymouth County but somewhat greater on most of the outer Cape than in 1942.
4. Black-headed fireworm normally abundant, about as in 1942.
5. Firebeetle (*Cryptoccephalus*), almost none.
6. Spotted fireworm (*Cacoecia*) rather prevalent, but less so than in 1942.
7. False armyworm (*Xylena*) normally abundant, less prevalent than in 1942.
8. Cranberry girdler (*Crambus*) more abundant than for many years.
9. Cranberry weevil (*Anthonomus*) normal in abundance.
10. Cranberry spittle insect and tipworm fully as troublesome as usual.
11. Spanworm infestations generally light.

**Control of Cranberry Bog Weeds.** (Chester E. Cross.) About 50 experiments in chemical weed control gave the following results:

1. Kerosene is decidedly more toxic to rushes when sprayed in April and early May than at any time later in the growing season. At 400 gallons per acre, kerosene killed *Juncus bufonius*, *J. canadensis*, *J. acuminatus*, *J. effusus*, and *J. pelocarpus*. No injury to cranberry flower buds resulted from kerosene spraying till treatments were made on May 28.
2. Gasoline sprayed on bogs at 200 and 400 gallons per acre caused no injury to vines in treatments made before May 15. Horsetail, loosestrife, and various grasses and rushes were killed by the sprays.
3. Various concentrations of lime-sulfur solution were sprayed on bog weeds late in April. Neither weeds nor cranberry vines were injured by them.
4. Ammonium sulfamate sprays were as toxic to cranberry vines in April and May as they are later after the development of new growth. Ivy sprayed with these solutions before sending out its leaves in the spring showed no injury.
5. Established clumps of *Juncus canadensis* were completely killed on new bog by pouring into each 25 cc. of a copper sulfate solution of 1 pound in 20 gallons of water. The adjacent hill cranberry vines were not injured.

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## DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

**Nutritive Value of Milk—Plain versus Chocolate Flavored.** (W. S. Mueller.) The toxicity of cocoa powder was found to be correlated with its tannic substances content. Therefore, if cocoa could be analyzed accurately for tannic substances, then dieticians could select a cocoa powder which is low in these substances and thus avoid most of its toxic effects.

None of the various methods for the determination of tannic substances in cocoa powder which were investigated proved entirely satisfactory. Commercial cocoa powder contained on an average 11 percent of tannic substances, as determined by the Ulrich method, which is the one most commonly used today. Ulrich's method was modified and improved. By this improved method, commercial cocoa powder contained an average of only 9.5 percent of tannic substances.

Overrun of chocolate milk is an important consideration in formulating laws or regulations pertaining to the product, and in determining plant losses, cost of the product, and nutritive value. Commercial chocolate milk was found to vary in overrun from 4 to 14 percent. The average overrun was higher in chocolate milk prepared with syrup than in chocolate milk prepared with dry ingredients because the syrup often contains a considerable amount of water. A formula has been developed for computing the overrun in certain kinds of chocolate milk, and it is expected that further study will make it applicable to all chocolate milks.

Indications are that the destruction by cocoa of certain vitamins in milk may be significant. This should be of interest to the many nutritionists who have endorsed the inclusion of cocoa in milk as a means of adding more widespread appeal to this protective food.

**A Study of the Effect of Certain Antioxidants on the Flavor and Keeping Properties of Milk and Some of Its Products.** (W. S. Mueller.) Further attempts were made to find a chemical method which would detect and measure oxidative rancidity in butter and other dairy products. The method desired is one that will (1) detect the very earliest stages in the process of rancidification, (2) measure quantitatively the state of oxidation, and (3) make possible a comparison of the potential keeping qualities of various dairy products.

The "chlorophyll value" test, which has been recommended for testing vegetable oils, has been investigated and appears to have a doubtful value as a test for butter fat rancidity or stability. This test appeared to measure the degree of rancidity which had been activated by light, but not that activated by heat. The chief difficulty encountered when this test was applied to butter fat was the masking of the "endpoint" in the titration by the yellow fluorescence of butter fat. The use of various light filters did not remedy the difficulty.

**Sterilizing Agents for Dairy Use.** (W. S. Mueller, E. Bennett, and J. E. Fuller.) In an attempt to find a sterilizer for dairy equipment which would take the place of chlorine, 45 samples of wetting or cationic agents have been collected, and 15 of these samples have been compared with a commercial chlorine sterilizing compound. Of the 15 samples already studied, 8 showed sufficient sterilizing properties to warrant further study, while 7 were discarded as ineffective.

Potassium meta bisulfite was found to be unsuitable as a sterilizing agent for dairy equipment because it was too corrosive to metals and also because its sterilizing properties were too weak. This was found to be true for acid sodium sulfite also. Sulfur dioxide was found to be a strong sterilizing agent but very corrosive. Buffering all three of the sulfur compounds in order to reduce their corrosiveness also greatly reduced their sterilizing properties.

The fact that sulfur compounds are excellent fungicides has led many people to believe that they are also good germicides. The negative results obtained in this study should aid in clearing up the misconception.

**Effect of High-Temperature Short-Time Pasteurization on the Ascorbic Acid, Riboflavin, and Thiamin Content of Milk.** (A. D. Holmes, H. G. Lindquist, C. P. Jones, and Anne W. Wertz.) Over a period of 18 months, samples were taken from 30 lots of raw milk, and taken again after the milk had been pasteurized by the high-temperature short-time method of pasteurization (in an Electro-Pure pasteurizer) at temperatures varying from 161° to 181°F. The vitamin assays for ascorbic acid, riboflavin, and thiamine showed that there were no significant losses of these vitamins due to this method of pasteurization.



## DEPARTMENT OF ECONOMICS

Philip L. Gamble in Charge

**Effects of the War and Readjustments in Massachusetts Agriculture.** (David Rozman.) Recent agricultural production trends in Massachusetts have been analyzed, primarily on the basis of AAA records from farm contacts, to determine farm needs, particularly labor requirements for achieving maximum production under war-time conditions. From this analysis it appears that 59.1 percent of all farmers depend on hired labor; of these 9.7 percent use only year-round labor, 29.5 percent only seasonal labor, and 19.9 percent both regular and seasonal. On dairy farms dependency on hired labor, expressed in man work units, varies from 24 percent of total farm work in the Connecticut Valley to 49 percent in Norfolk County. For other counties the dependency of dairy farms on hired labor is as follows: Essex 42; Worcester 26; Berkshire 33; Plymouth 46; Barnstable 27; Bristol 24; and Middlesex 36 percent.

On the basis of war-time requirements for food and the necessity of concentrating on the most economical types of production, determination has been made of the maximum production capacity of Massachusetts agriculture. This has been prepared in cooperation with a college committee in connection with the national program of agricultural adjustment. In working out this program stress has been placed on obtaining a greater amount of direct food crops from Massachusetts land resources and on making more efficient use of local grasslands to relieve the pressure on imported feed for the maintenance of our increased numbers of livestock.

## DEPARTMENT OF ENGINEERING

C. I. Gunness in Charge

**Cranberry Storage Investigation.** (C. I. Gunness, H. J. Franklin, and H. F. Bergman.) Early Black cranberries from the 1943 crop were stored in a refrigerated storage at 45 degrees and a similar lot stored in a commercial screen house provided with natural ventilation. The berries were picked and stored on September 8, 1943, and removed from storage on November 2. Those stored at 45 degrees suffered a storage loss of 7.2 percent, while those stored in the screen house showed a loss of 26.5 percent. These results are typical of results obtained in former years. The losses could have been reduced still more if the berries had been held at a lower temperature, the least loss occurring at 35 degrees.

An attempt was made to hold cranberries in a modified atmosphere containing 5 percent carbon dioxide and 2 percent oxygen, but failure to make the room air-tight upset this experiment and no results were obtained.

**Poultry House Investigation.** (C. I. Gunness and W. C. Sanctuary.) Observations on ventilation of poultry houses were continued during the two seasons 1942-43 and 1943-44. In the first season observations were limited to three pens which had also been observed during 1941-42. One pen was completely insulated, one partially insulated, and one non-insulated. In 1941-42 all pens were ventilated with natural draft. The litter in the non-insulated pen contained 36.6 percent moisture on March 11, that in the partially insulated pen 26.3 percent, and that in the insulated pen 25.9 percent. The observation made on March 11 is indicative of the general condition of the litter throughout the season. In 1942-43 the insulated pens were run as in the year previous but an electric fan was installed in the non-insulated pen, drawing in 60 cubic feet of air per



minute for the 100 hens in the pen and recirculating about 500 cubic feet of air over the litter. The litter that year had about the same moisture content in all three pens. This arrangement produced more floor draft than was desirable, so a smaller fan was installed for 1943-44 with a circulation of only 150 cubic feet per minute over the litter. This apparently was not sufficient to keep the moisture content of the litter down to that in the other pens. Another attempt will be made during the coming season to obtain sufficient circulation to keep the litter dry without creating an objectionable floor draft. No attention was given to adjustments or changes in the ventilation of the fan-ventilated pen either season, a feature which is of considerable interest to the poultryman.

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## DEPARTMENT OF ENTOMOLOGY

Charles P. Alexander in Charge

**Investigation of Materials which Promise Value in Insect Control.** (A. I. Bourne and W. D. Whitcomb.) Work on the cooperative project was continued with attention focused on several lines of research.

Tests were made to study the effect on apples of adding DN-111 to the standard spray combination of lead arsenate and wettable sulfur in the regular applications immediately following bloom. The calyx application (May 27), made under conditions of moderate temperature and humidity and followed by similar weather conditions, caused no injury whatever. The first cover spray (June 3), however, was followed by general and quite conspicuous burn, which was most extensive on Baldwin and Greening and considerably less on Wealthy and Cortland. By mid-July the falling of the worst affected leaves and development of new growth had very nearly obliterated any evidence of injury. No appreciable cut in yield was noted.

On July 20 and August 9 sprays were also applied to peaches, pears, plums, and cherries in the college orchard and no ill effects were noted. Temperature in the period following the sprays rose to 80° or above.

Applications of DN-111 and D-4 to approximately 20 different types of deciduous ornamentals indicated that during June these materials, even at moderate temperatures, caused moderate to serious injury in most cases; while in late July and August similar applications, even at temperatures as high as 84°, caused no evidence of any damage to foliage, almost without exception.

Counts of red mite made 24 hours after application of D-4 dust showed 56 mites per 100 leaves compared with 2296 mites on leaf samples taken just before dusting, a 97 percent reduction. DN-111 at 1¼ pounds to 100 gallons in similar tests gave 95 percent reduction, and at 1 pound to 100 gallons, a 98 percent reduction. The difference in results was due to the density of foliage and difficulties in securing thorough coverage in the case of the trees given the 1¼-pound dosage.

Summer applications of dinitro materials are often coincident with the presence of honeybees working the blossoms of cover crops in the orchard. Beekeepers are very sensitive to the possibility of losses from sprays and dusts, and every new material used for insect control becomes an object of suspicion. In tests to determine the effects of dinitro compounds on bees, D-4 dusted on honeybees caused only slightly greater mortality than occurred on normal bees in the same length of time. When compared with rotenone, nicotine, or pyrethrum dusts, the toxicity of D-4 was very low. DN-111 (at a dilution of 1¼ pounds to 100 gallons) in a sugar solution proved to be more toxic, for all the bees in the test died within 5 days.

In summer applications of DN-111 at Waltham, on McIntosh and Northern Spy trees infested with 18 to 21 European red mites per leaf on July 28, a spray of DN-111, 1 pound in 100 gallons, and a spray of DN-111, 1 pound, lead arsenate 3 pounds, and wettable sulfur 4 pounds in 100 gallons, each reduced the population of mites 98 percent six days after the treatment. A natural reduction of 11 percent occurred on the unsprayed trees during this period. Thirteen days after these sprays were applied, the mite population had been reduced 97 percent. The natural reduction on unsprayed trees was 94 percent.

On Baldwin trees having an infestation of 381 white apple leafhoppers per 100 leaves on August 31, a spray of DN-111, 1 pound in 100 gallons, reduced the population 94.7 percent eight days later, while a natural decrease of 9.02 percent occurred on unsprayed trees.

**Potato Spraying Experiments.** (A. I. Bourne.) The experimental plots were planted May 7, and the plants in all the plots were alive and green up to the first killing frost on October 5 and 6. The potatoes were dug (by machine), picked, and bagged on October 13.

Potato flea beetles appeared as soon as the plants were above ground and persisted in great abundance until mid-August.

Leafhopper infestation was comparatively light, and no records of serious outbreaks were received.

During late June and early July there was a very considerable amount of stalk infestation by European corn borer larvae. While the number of injured stems was high, most of the damage was confined to lateral stems, so that for the most part the attack simply caused a moderate pruning and the injured growth was very soon replaced. Hundreds of second-brood moths were harbored among the plants during the day, but there was little or no evidence of late-summer injury by second-brood larvae.

Potato aphids developed a serious infestation following the very hot and dry weather of early July. Delay in applying control measures and temporary local shortages of nicotine allowed serious infestations to build up in several large commercial plantings. A thorough application of nicotine in the sprays of July 20 and 28 eliminated these insects as a source of danger in the experimental plots. These two applications were made on bright, sunshiny days with temperature ranging from 84° to 86° to facilitate the rapid evolution of nicotine.

The test plots received 10 applications at approximately weekly intervals from July 15 to September 3. Because of the war emergency and to conserve copper, the bordeaux mixture was based on a 8-8-100 formula instead of the standard 10-10-100 strength.

There was practically no disease in any of the plots. Out of more than 233 bushels of potatoes harvested, only 18 pounds were discarded because of disease.

Evaluation of the different treatments on the basis of flea beetle damage showed a definite increase in protection following the use of calcium arsenate. The addition of calcium arsenate reduced flea beetle damage by 16½ percent in the plots which received the standard 4-4-50 bordeaux; in the plots which received the 4-2-50 bordeaux the reduction was 32½ percent; and in the plots which received half strength bordeaux the reduction was 35 1/3 percent. In all the plots in which bordeaux plus calcium arsenate was applied, the average number of leaf punctures per square inch of leaf surface was practically the same regardless of the strength of bordeaux. There was a marked difference, however, in the amount of flea beetle feeding in the plots which received bordeaux alone. Compared with the 4-4-50 plot, the average number of feeding punctures per square inch of leaf surface in the low calcium plot was 28 percent greater; and in the 2-2-50 bor-

deaux plot, 35 percent greater. This would indicate that, regardless of the copper content, in any low-calcium bordeaux the addition of calcium arsenate is important for protection against flea beetle attack.

In general, increased yields were recorded in the plots where calcium arsenate was added to the bordeaux. In one small plot which received a low-copper - high-calcium bordeaux, the yield fully equalled that in the standard 4-4-50 bordeaux plot.

**Castor Bean Extractives.** (A. I. Bourne.) Preliminary tests of an insecticide based on extractives of the castor bean plant with ricine as basic constituent showed that the material had excellent wetting and spreading qualities, even on plants with a waxy surface such as onions. As a contact spray against certain species of aphids, the material has shown very definite promise. Several tests were made to check the tolerance of various types of garden plants and ornamentals, and in no case was any injury to foliage noted.

The material showed fairly good results against onion thrips. Apparently all that were actually hit by the spray were killed; in other words, all those which were feeding exposed on the leaves.

The material seemed to have a repellent effect, as there was very little evidence of feeding by the Mexican bean beetle after it was applied.

**Control of Onion Thrips.** (A. I. Bourne.) There was a comparatively light infestation of thrips in the Connecticut Valley in 1943, and most of it was well distributed over the fields of set onions. The combination of thrips migration in middle and late July and hot, dry weather in early August promoted a rapid increase in thrips population on seed onions, which was maintained at a high level until well beyond mid-August.

A dinitro dust prepared for use on growing plants reduced the number of thrips from 31 per plant to 3, a 91 percent reduction. The application was heavy and a slight trace of burn was noted. The material gave definite promise.

The standard combined spray of nicotine sulfate and soap gave 90.2 percent reduction of thrips. Derris and Ultrawet reduced thrips from 100 per plant to 14, an 87 percent reduction, and also showed a pronounced residual action. A dinitro spray (prepared for summer use) proved 92 percent effective but showed little residual effect. A new antimony compound furnished for experimental use by the Crop Protection Institute showed good killing action but possessed somewhat inferior wetting and spreading qualities on the smooth waxy leaves of onion. In spite of this handicap it gave 84 percent immediate reduction in the number of thrips and reinfestation was slow.

**Control of Cabbage Maggot.** (W. D. Whitcomb, Waltham.) For the second consecutive year, Early Jersey Wakefield cabbage showed definite resistance to injury by the cabbage maggot, 87 percent of the plants being commercially uninjured, while seven other varieties of different types suffered from 20 to 64 percent more injury. Golden Acre, with only 23 percent commercially uninjured plants, showed the greatest damage.

The first eggs were found on May 10, 1943, and the general field infestation was moderate, 77 percent of the untreated plants being commercially injured.

The most effective treatment was the application of calomel-talc dust in a mound around the stem of the plant. Perfect commercial control was obtained from dust containing either 4 percent calomel or 2 percent calomel, although the 4 percent calomel-talc dust gave 10 percent more actual protection than the 2 percent dust. Corrosive sublimate solution in two applications at weekly intervals gave good control at concentrations of 1-1280, 1-1920, and 1-2560. For



each reduction of 50 percent in concentration, the effectiveness was reduced about 7 percent. Semesan at the rate of 3 ounces in 10 gallons of water gave 86 percent protection in two applications. Tar paper discs when applied carefully gave perfect commercial control on both cabbage and cauliflower, and it was demonstrated that this is the most practical treatment in the home garden.

The results of these studies have been summarized and published in Bulletin 412.

**Control of Squash Vine Borer.** (W. D. Whitcomb, Waltham.) The field infestation of the squash vine borer at Waltham in 1943 was moderately severe, averaging 4 borer injuries per vine in Blue Hubbard and 2 per vine in Buttercup. The Buttercup is a relatively small-stemmed variety and appeared to be less attractive to the borer, but the borer injury was more destructive to the vine than to the larger-stemmed Blue Hubbard.

Four applications at weekly intervals during July of nicotine sulfate 1-250, and nicotine sulfate 1-500, plus Volck 1 percent, gave good control and reduced borer injury 72 and 80 percent. The addition of bordeaux mixture 2-2-50 to these sprays failed to cause significant differences either in borer control or yield.

The addition of 33 percent cryolite to a nicotine-copper dust increased the control 25 percent and gave satisfactory protection.

**The Value of Control Measures to Supplement the Standard Spray Program for Apple Pests in Massachusetts.** (A. I. Bourne, in cooperation with the Departments of Pomology and Plant Pathology.) All of the early-season sprays were applied within a temperature range of 57° to 67° and with low to moderate humidity. In the subsequent cover sprays the temperature range was 66° to 80° and humidity moderate. No evidence of spray injury was noted throughout the entire season.

The season proved to be very favorable for most insects and especially so for scab. Foliage infection was evident very generally in all blocks, although the fruit was fairly well protected. Unsprayed checks showed 96 percent scabby fruit.

Examination of the fruit at harvest showed 23 percent codling moth and 17 percent curculio damage and 5 percent scab on the plot which received the standard schedule. Unsprayed trees showed 72 percent codling moth, 66 percent curculio, and 96 percent scab.

A special application of fixed nicotine between the 2d and 3d cover sprays reduced codling moth damage to 13 percent, a reduction of nearly 44 percent from that in the standard schedule.

The nicotine in DX base, in a modified schedule with reduced strengths of lead arsenate, held codling moth damage to 5 percent, a 78 percent reduction from the standard schedule, with approximately the same protection against scab.

One application of a fixed nicotine spray replacing lead arsenate in the 4th cover spray reduced codling moth injury to 7 percent; and when an additional application of fixed nicotine followed in mid-August, injury was cut to 5 percent, a reduction of 78 percent from the standard schedule and 92 percent from the unsprayed checks.

**Insecticides for the Control of European Corn Borer.** (A. I. Bourne.) Throughout practically all the Northeastern States, European corn borer developed one of the heaviest infestations and caused the greatest amount of damage in recent years. Relaxation of fall clean-up programs did much to aggravate the situation. Damage was not confined to corn. Potatoes were heavily infested by first-brood



larvae and early varieties were severely damaged. Many varieties of flowers were attacked, and some commercial plantings of dahlias were ruined.

In the middle Connecticut Valley moths were emerging by May 24, and the larvae began to appear by June 10. In the experimental plots insecticides were applied on June 11, 16, 21, 25, and 30. Precipitation was comparatively light during this period and caused no serious interference with any application.

Preharvest examination of the experimental plots for early evidence of attack showed that 85 percent of the plants sprayed with derris, 89 percent of the plants dusted with fixed nicotine, 55 percent of the plants given fixed nicotine sprays, but only 15 percent of the unsprayed plants were free from infestation. Subsequent counts of borer population showed an average of  $5\frac{1}{2}$  borers per plant in the check plots,  $2\frac{1}{2}$  in the fixed nicotine sprayed plots, 2 in dusted plots, and  $1\frac{1}{2}$  in the plots sprayed with derris.

In the dusted plots 95 percent of the corn harvested was free from borers, and 94 percent of the total yield was of marketable grade. In the plots sprayed with derris, 91 percent of the ears were clean and 89 percent of marketable grade. A schedule of fixed nicotine spray at 3 pounds to 100 gallons dosage gave 90 percent of the yield free from injury and 86 percent of marketable grade. A 2-pound dosage allowed 89 percent borer free ears, with 85 percent of the total yield of marketable grade. In the unsprayed check plots, while 64 percent of the crop harvested was borer free, only 55 percent of the total yield was fit for market.

In late pickings the contrast between treated and check plots was greater. Only 35 percent of the last picking in the check plots was of marketable grade.

**Introduction of Parasites of Oriental Fruit Moth in Peach Orchards.** (A. I. Bourne.) The fruit buds of peaches were practically all destroyed by the unusually low temperatures of the winter (1942-43) in Massachusetts, and some injury to the wood also resulted. There was practically no peach crop in this State or throughout most of the northern peach-growing area. Only two growers requested *Macrocentrus* parasites of the oriental fruit moth and these orders were filled by purchase from the Connecticut Agricultural Experiment Station through the cooperation of Doctors Friend and Garman. A few colonies for experimental release were supplied by Dr. H. W. Allen of the U. S. Bureau of Entomology and Plant Quarantine Laboratory, Moorestown, N. J.

**Apple Maggot Emergence.** (W. D. Whitcomb.) In 1943 the number of apple maggot flies was generally below normal but many of the flies remained active and laid eggs over a long period, which resulted in moderate infestation in many commercial orchards and heavy infestation in home orchards.

The emergence of flies in the cages at Waltham was the lowest since the cages have been in operation, being only 9 percent of the possible total and 18 percent of the expected total.

*Emergence of Apple Maggot Flies, 1943, Waltham, Mass.*

	Cultivated Soil	Sod
First Fly Emerged	June 25	July 6
25 Percent of Flies Emerged	July 9	July 6
50   "   "   "   "	July 14	July 10
75   "   "   "   "	July 26	July 15
Last Fly Emerged	August 6	August 5

**Control of Common Red Spider Mite on Greenhouse Plants.** (W. D. Whitcomb, Wm. Garland, and Wm. E. Tomlinson, Jr., Waltham.) Life history studies of the common red spider mite at constant temperatures were continued

on various host plants particularly beans, lettuce, and cucumber. Significant differences in the life cycle on different host plants were found but they were not so consistently correlated with the pH of the plant sap as in previous studies, indicating that other factors may be involved. About twice as many eggs were laid on beans as on the other host plants in this series.

Spraying experiments on greenhouse roses showed that 4 applications of 40 percent nicotine sulfate 1-400 with or without soap did not control the common red spider mite satisfactorily, but permitted the spider population to remain at about 40 per leaf throughout the experiment. A commercial thiocyanate spray which has been recommended as a substitute for rotenone sprays during the war emergency gave good control of the pest on roses but caused severe injury to foliage even when diluted 1-1200.

In further experiments with a commercial mixture containing 20 percent di-cyclohexylamine di-dinitrocyclohexylphenate, good control on roses was obtained with 3 applications of spray containing  $\frac{1}{2}$  ounce and 1 ounce of the toxicant in 100 gallons of water, and excellent control with 1 to 3 applications of spray containing 2, 3, or 4 ounces in 100 gallons. About 4 ounces of the toxicant in 100 gallons of water was the critical dosage, and nearly perfect control was obtained whether this amount was applied in several applications at a smaller dosage or in one application at the critical dosage. On carnations the mortality was about 30 percent greater than on roses when less than a critical dosage was used but about equal when a dosage of 4 ounces per 100 gallons, or more, was applied.

No foliage injury from the DN spray occurred on roses or carnations in these experiments. Foliage injury resulted on chrysanthemums and in another series on roses, when this material was combined with a neutral copper (26 percent metallic) fungicide 1-50; and growers have reported injury from this combination during high temperature in mid-summer.

**Napthalene and Similar Compounds as Greenhouse Fumigants.** (W. D. Whitcomb and Wm. Garland, Waltham.) Experimental fumigations with a mono-dichloronapthalene-napthalene mixture previously reported were continued, and a series of studies at controlled temperatures and relative humidity was completed.

**Control of Plum Curculio in Apples.** (W. D. Whitcomb, Waltham.) In 1943 the curculio infestation was the greatest in the history of the Waltham Field Station orchard and 90 to 100 percent of the fruit on unsprayed trees was damaged.

The gallonage experiments in which  $\frac{3}{4}$ , 1, or  $1\frac{1}{4}$  gallons of spray was applied to each 100 square feet of area of the tree were continued. With the extremely heavy infestation, the  $\frac{3}{4}$ -gallon dosage was inadequate. The 1-gallon dosage was the best. The  $1\frac{1}{4}$ -gallon dosage was inconsistent, being the least effective on Wealthy and Spy and the most effective on McIntosh.

Cryolite at the rate of 4 pounds in 100 gallons was 12 to 17 percent less effective than lead arsenate at the same rate and russeted the fruit of Delicious badly. DN-111 at the rate of 1 pound in 100 gallons failed to control the curculio and caused a definite bleaching of the leaf veins following successive applications to tender foliage at the pink and calyx periods.

**New Fruit Insect Pest.** (W. D. Whitcomb.) A general outbreak of the spotted tentiform leaf miner (*Lithocolletis blanchardella* Fabr.) occurred throughout Worcester and Middlesex Counties in 1943, with particularly severe infestations in orchards at Marlboro and Groton. Although this insect has been present in

Massachusetts for several years, it has never been so destructive as it was in some orchards this year. Many of the infested trees lost one-third or more of their leaves and the remainder were badly mined.

Reports indicate that this leaf miner is not likely to be an annual pest but may be abundant for 2 or 3 years after which it is held in check by parasites. Satisfactory control should be obtained by spraying with nicotine sulfate when the moths are flying and laying eggs. There are usually three generations annually; but if the first generation is controlled by spraying at about the pink bud stage, further infestations will be prevented.

**Biology and Control of the Grape Plume Moth and Grape Cane Girdler.** (W. D. Whitcomb and Wm. E. Tomlinson, Jr., Waltham.) Studies of the Grape Plume Moth were completed and the results were published as Bulletin 409.

Insectary studies of the grape cane girdler were conducted on potted grape vines. The first eggs were laid by caged beetles on June 2 and oviposition continued until July 14. The greatest number of eggs was laid June 3 and 4, and 77 percent were laid from June 3 to 21. The average number of eggs laid was 10.5 per female, but two beetles laid 16 eggs each. The average length of life from oviposition to adult was 47.5 days of which 20 were spent as a boring grub in the grape cane. Limited observations on caged beetles indicate that they hibernate under stones and long grass rather than under fallen grape leaves beneath the vines.

Spraying the vines with cryolite 3 pounds and Fermate 1 pound gave better protection than applications of lead arsenate and bordeaux mixture or wettable derris powder.

**Biology and Control of the Celery Plant Bug.** (W. D. Whitcomb, Waltham.) The celery plant bug (*Lygus campestris* L.) continued to be destructive to celery in the Boston market garden area in 1943, and some fields suffered losses as high as 50 percent of the early crop and from 10 to 25 percent of the late crop. The loss on the early crop was correlated with hot weather during the early part of the growing season which caused heart rot and seed stalk development that was easily confused with plant bug damage. Severe heart rot and dwarfing of the plant was definitely connected with plant-bug injury in cages where celery confined with 2 bugs per plant was severely injured; while celery from which plant bugs were excluded, and where the heart stalks were punctured by a needle to imitate plant-bug injury, grew normally.

The bugs spend the winter as adults, and in 1943 they first appeared in the celery plantings about May 15. There are two generations during the summer. The number of first generation bugs per 100 plants was greatest from June 26 to 29 soon after the majority of the nymphs had hatched. During hot weather the period from hatching to adult is about 35 days, and 98 percent of the bugs had become adult on July 10. At Waltham the white celery varieties such as Supreme Golden and Early Fortune were most heavily infested, having 173 to 199 bugs per 100 plants at the peak of infestation.

The first infestation on late celery was observed about July 13, about 2 weeks after the plants were set out, and nymphs were found on July 20. Two peaks of infestation of the second-generation bugs developed on the celery, first on August 17 and again on September 11 to 14.

Insectary studies in late August and September showed the average period from egg to adult to be 45 days. This period varied from 39 to 43 days while the mean daily temperature was 66° to 67°F., and from 48 to 50 days when the mean temperature was 61° to 62°. Incubation of the egg required 9 to 13 days,



averaging 11.16 days. There are five nymphal stages, the first four requiring 4 to 6 days and the last averaging 12.8 days.

In the late planting the white and yellow varieties of celery were more heavily infested than the green varieties, averaging 73 more bugs per 100 plants in the semi-weekly counts. The most heavily infested variety was Fullheart, with 3749 bugs per 100 plants during the season and 320 per 100 plants at the maximum infestation on September 11. The most resistant variety appeared to be Morse's Utah, a coarse green variety which does not bleach well. It had only 538 bugs per 100 plants throughout the season, and 44 per 100 plants at the height of the infestation. The standard variety, Summer Pascal, had a low infestation throughout the season.

Spraying and dusting experiments against the first brood of bugs on early celery showed satisfactory protection from nicotine dusts and sprays, and from nicotine-pyrethrum dust in three applications. The nicotine-pyrethrum dust reduced the number of bugs 97 percent, and only 4 live bugs per 100 plants were found in counts made one day after treatment. Black Leaf 155-bordeaux mixture spray, and Black Leaf 155-lime dust also gave good protection. On the untreated plants the infestation increased 81.3 percent during the period.

On the second planting, the nicotine-pyrethrum dust again gave the best protection. When applied at weekly intervals between July 19 and September 20, only 95 bugs per 100 plants were found during the season, compared to 350 bugs per 100 plants on the untreated check. Counts on the day following application showed a 95 percent reduction in the number of bugs from this dust. The addition of 2 pounds of soap flakes dissolved in each 100 gallons increased the effectiveness of nicotine sulfate spray 1-800 by 28 percent, and of a commercial pyrethrum spray 1-400 by 17 percent. The least effective treatment was nicotine sulfate 1-800 without soap, in weekly applications.

Applications with a spray gun which drove the spray into the heart of the celery were 5 to 10 percent more effective than applications with a mist nozzle.

Applications at intervals of 2 and 3 weeks reduced the number of bugs found 24 hours after treatment as much as weekly applications, but permitted greater reinfestation in proportion to the interval between treatments.

**Investigations on the Effect of Insecticides on Honeybees.** (A. I. Bourne and F. R. Shaw.) In feeding tests to determine the relative toxicity of arsenicals and fluosilicates to bees, fluorine compounds at the rates recommended for control of shade tree pests seemed to be fully as toxic as arsenicals. In a comparison of the effects of dusts on bees, rotenone and pyrethrum dusts were most toxic, nicotine was third, sulfur fourth, and DN dust fifth in order of toxicity. Since DN dust would be applied during the summer when bees are active, the fact that it did not cause appreciable death is significant.

Tests of materials suggested as bee repellents included creosote at various dilutions, carbolic acid, and a proprietary phenol compound known as Milkol. All creosote applications produced blossom injury. The heavier concentrations produced some leaf injury, which soon disappeared, however, because of the dropping of the affected leaves. Materials applied shortly after full bloom did not materially affect the set.

Experiments to determine the effect of the materials suggested as repellents on the length of life of bees were conducted by feeding the "repellent" material in sugar syrup. The length of life of bees fed these materials was compared with that of check lots receiving sugar syrup. In all instances the addition of the "repellent" shortened life. Whether this was due to insecticidal action or to starvation was not determined.



**Sprays to Prevent Scolytid Infestation of Individual Elm Logs.** (W. B. Becker.) *Orthodichlorobenzene and Fuel Oil.* At Amherst, unseasoned elm logs were thoroughly sprayed when dry with orthodichlorobenzene and No. 2 fuel oil mixed one to eight by volume and applied at the rate of 240 c.c. per square foot of bark. This was done on May 14, five days before *Hylurgopinus rufipes* (Eich.) beetles started to dig their first egg galleries in the vicinity. A small hand-operated compressed air sprayer was used. The crevices where the beetles commonly enter the bark were well saturated, and each log was turned over during the application so all sides could be reached. The sprayed logs together with unsprayed control logs were then exposed to beetle infestation in the shade. *H. rufipes* was the only scolytid which attacked the logs. Compared with unsprayed control logs of similar size, 99.5 percent prevention of *H. rufipes* infestation per square foot of bark was obtained, based on the number of brood galleries which became established in the logs. Based on the number of progeny which emerged from the bark during the season (beetle exit holes), 100 percent prevention was obtained; and based on the combined number of progeny which emerged and which were still present in November, 98.5 percent prevention was obtained by spraying.

*Creosote and Kerosene (strained).* Unseasoned elm logs were thoroughly sprayed with creosote and kerosene mixed one to four by volume and applied at the rate of 160 c.c. per square foot. This was done on May 20, one day after *H. rufipes* beetles started to dig their first egg galleries in the vicinity. Complete prevention of all *H. rufipes* infestation was obtained for the entire season. When this spray was applied to parts of other logs which were also subsequently piled in the shade, the unsprayed portions were infested with *H. rufipes*.

These results suggest that, under these conditions, thoroughly coating the entire bark surface with either of these two spray mixtures just before the beetles lay eggs in the spring may be expected to prevent *H. rufipes* infestation to a great extent for the entire season. If the entire bark surface is not thoroughly covered with a sufficient amount of spray material, the scolytids may infest the unsprayed portions. Since the beetles commonly dig into the bark at crevices, the spray must penetrate into all such places.

The large elm borer, *Saperda tridentata* Oliv., was also apparently repelled by both of these spray mixtures, but was abundant in the unsprayed logs.

While neither of these spray mixtures is pleasant to work with, the creosote-containing spray is much more disagreeable to handle. When the creosote is mixed with kerosene, a black precipitate is produced which must be removed before the liquid is poured into the spray tank. The fire hazard must also be taken into consideration with sprays of the type used in these experiments. However, these materials may prove useful in preventing infestation of logs thrown on town dumps and other locations where the fire hazard and injury to adjoining vegetation may not be a problem.

**Sprays to Kill Scolytids Breeding in Individual Elm Logs.** (W. B. Becker.) *Orthodichlorobenzene and Fuel Oil.* At Westfield,<sup>1</sup> scolytid-infested elm logs were thoroughly sprayed during July 1942 with the orthodichlorobenzene-fuel oil mixture described in the previous section, at the rate of 52.5 c.c. per square foot of bark. Both *H. rufipes* and *S. multistriatus* brood galleries with only immature progeny were in the logs at the time of spraying. None had emerged. After the spray application the sprayed logs, together with unsprayed control logs, were piled in partial shade. Compared with unsprayed logs of similar size, 79

<sup>1</sup> Mr. W. E. Marshman, the Westfield tree warden, kindly provided the logs for this experiment and a place where the work could be carried on.

percent mortality occurred in the sprayed logs, based on the number of surviving progeny (immature and emerged) of both species per brood gallery the next spring. Many *Saperda tridentata* Oliv. and some *Magdalis* sp. survived the spray application.

While 79 percent mortality is a considerable reduction, it would still allow more beetles to survive than is desirable in the case of a vector of a disease.

*Creosote and Kerosene.* Attempts to kill scolytids in elm logs by spraying the entire bark surface with 12.2 c.c. per square foot of the creosote-kerosene mixture described in the previous section were not at all successful. A heavier application might be more successful.

**The Prevention of *Hylurgopinus rufipes* (Eich.) Attack by Repeatedly Turning Unseasoned Elm Logs in the Sun during the Early Season Oviposition Period.** (W. B. Becker.) Freshly cut elm logs lying in a north-south direction in the sun at Amherst were rolled 180 degrees of their circumference (1) every week and (2) every second week during the early-season oviposition period of *H. rufipes* (May 19 to July 2 in 1943). Many egg galleries were started on the lower halves, but when the logs were turned so that the sun heated the bark above the temperature which the beetles could tolerate, development in almost all cases stopped. Relatively few egg galleries reached the stage where eggs were laid in them — fewer in the logs turned every week than in those turned every second week. Of those larvae which developed from these eggs, most died when still very small. No attacks occurred after July 2, which was the last date the logs were turned. On one large log which was left in the sun unturned from May to November, the upper half was not suitable for the construction of egg galleries, while the lower half was. In comparison with control logs piled in the shade, logs turned over at one-week intervals were practically free from infestation, both on the basis of the number of beetles, per square foot of bark, which had emerged by the end of the season (November) and on the basis of the combined number of emerged progeny and immature progeny still in the bark at the end of the season. The control was practically as good where logs were turned at two-week intervals. When the logs were examined in November, none seemed to be in a condition which would be suitable for further attack the next spring.

The successful results obtained in this experiment suggest that, in certain situations, this method might prove useful in preventing an increase in the local beetle population. Of course, warm sunny weather is necessary. However, since experiments were started here in 1939, solar-produced heat has always prevented elm bark scolytids from becoming established in all or most of the upper half of elm logs exposed to the sun since spring.

**Combined Use of Sprays and Solar Heat on Individual Elm Logs.** (W. B. Becker.) Individual unseasoned elm logs laid in a north-south position in the sun at Amherst on July 2, 1943, were sprayed on the top half with (1) the ortho-dichlorobenzene-fuel oil mixture and (2) the creosote-kerosene mixture previously described and then rolled over so the sprayed half was underneath. Unfortunately, not enough *H. rufipes* beetles attacked even the control logs to furnish any comparative data. However, since attacks on entire individual logs in the shade have been prevented by spraying, and attacks on most of the upper half of untreated logs have been prevented by laying them in the sun, it seems possible that (1) laying logs to be sprayed in the sun may save much spray material since only slightly more than half of the bark area on each log need be sprayed, and (2) spraying the under half of logs in the sun may save returning at a future date to turn them over.

### Spray Coverage on Elm Logs in a Pile of Cordwood. (W. B. Becker.)<sup>1</sup>

Good spray coverage was obtained on elm logs in a pile of logs of cordwood length by using a six-opening spray gun and a power sprayer giving 400 pounds pressure. The pile sprayed included approximately six feet of a longer pile four feet high. The spray was directed into the pile from the ends of the logs and from the top of the pile. Approximately 12 to 15 gallons of a spray (Elgetol) which left a visible deposit were applied. Immediate examination revealed that of 22 elm logs scattered throughout the pile, 12 were completely coated with spray, 9 were approximately 85 percent or more coated, whereas only one was as little as half coated. The bark surfaces not coated were areas protected from the spray stream by a branch stub or a cross stick in the pile, or where the surface of two adjoining logs lay flat against each other.

If satisfactory spray coverage can be obtained on logs inside a pile, it may facilitate the treatment of log piles to repel or kill the scolytids which are vectors of the Dutch elm disease.

### Miscellaneous Biology Studies with *Hylurgopinus rufipes* (Eich.). (W. B. Becker.)

*Beetle Emergence Throughout the Day.* Although emergence of young adults from logs fluctuated from day to day and from hour to hour, seemingly being affected by the weather, by far the most of it occurred between mid-morning and late afternoon. This was shown by emergence during 1936 and 1943 from logs caged outdoors in partial shade. During 18 days in the late summer of 1936 the average emergence between the following hours (E. S. T.) was: 6-8 a.m. 1.9, 8-10 a.m. 2.8, 10-12 noon 33.9, 12-2 p.m. 69.9, 2-4 p.m. 31.4, 4-6 p.m. 8.4. During the 18 overnight periods (6 p.m. to 6 a.m.) an average of only 2.8 beetles emerged. During 15 days in the late summer of 1943 the average emergence between the following hours was: 7:30-9:30 a.m. 3.66, 9:30-11:30 a.m. 22.53, 11:30 a.m.-1:30 p.m. 63.06, 1:30-3:30 p.m. 53.06. During nine overnight periods (3:30 p.m. to 7:30 a.m.) the average emergence was only 2.78 beetles.

*Sex Ratio:* The proportion of males to females was approximately one to one. Both sexes started to emerge from logs at the same time in mid-summer and the daily emergence of the sexes did not vary significantly throughout the season. Between July 29 and August 26, 1938, 123 males and 99 females emerged from some caged logs. Of 757 adults selected at random from specimens collected all season, 383 were males and 374 were females. In 1943, 304 males and 309 females emerged from small caged logs between August 4 and September 4.

*Some New Findings of *Scolytus multistriatus* Marsham in Massachusetts.* (W. B. Becker.) One adult beetle was found in a log which had been exposed to scolytid attack in 1942 at Amherst.

*Insect Pests of Wood and of Shade, Forest, and Ornamental Trees in Massachusetts.* (W. B. Becker.) During 1943 over 200 inquiries were received about these insect pests. Ants, termites, powder post beetles, aphids, and secondary tree-boring insects were received most frequently.

<sup>1</sup> Professor A. I. Bourne provided valuable assistance in planning this experiment.



## DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

**Disease Resistance and Heredity of Carnations.** (Harold E. White, Waltham.) Flower petal counts made on blooms from 42 varieties of carnations show that there is considerable variation in the number of petals per bloom within a variety. A few varieties were very consistent in the number of petals per flower produced. When the varieties were grouped for comparison on the basis of average number of petals, 40 percent had an average count of 25 to 50 petals; 35 percent, 50 to 60 petals; and 24 percent, 60 to 80 petals per flower. The variety Silveryln had the highest average number of petals, 97 per bloom.

Flowers with split calyces were not abundant enough for an accurate analysis of petal number as related to splitting, but material available for inspection revealed no correlation between number of petals present and degree of splitting. Extra floral parts such as ovules were found in both normal and split flowers; but, as extra ovules occurred very frequently in both types of flowers, such a condition could not be associated with the splitting character in commercial varieties.

Some 500 progeny were obtained from crosses made between disease-resistant and susceptible varieties, but data as to the hereditary nature of the disease resistance are not sufficient for analyses. The progeny segregated for two types of double flowers: 50 percent commercial doubles (normal) and 25 percent bursters (abnormal doubles); and 25 percent were singles. The data seem to indicate that splitting of calyces is of two types. One, due to specific hereditary factors, induces formation of an abnormal number of extra buds and multiplicity of floral parts within the individual blooms. Dissection of a number of the bursters produced in the seedlings showed that there were from 100 to 150 petals present and 5 to 10 immature ovules per bloom. The second type of splitting occurs in variable degrees with commercial varieties and would seem to be influenced more by environmental factors than by heredity.

Cotyledon number of seedling carnations varies from two to three and the seedling leaf character segregates in a 1 to 1 ratio. No structural characteristics were observed to be associated with difference in cotyledon number.

**Breeding Snapdragons for Varietal Improvement and Disease Resistance.** (Harold E. White, Waltham.) Trials of eight Waltham Field Station strains of rust-resistant snapdragons with Yoder Brothers in Barberton, Ohio, showed the strains to be highly resistant to rust and valuable for outdoor culture as well as worthy of inclusion in the firm's hybridizing work with snapdragons.

Provisions were made for more extensive tests of the rust-resistant qualities of these strains by distribution of seed to eight experiment stations and one seed firm in this country. Requests for trials were received from Pretoria, South Africa, and Victoria, Australia.

The rust-resistant character of the strains has shown no indication of breaking down, and no mutant strains of the rust fungus have been observed. Selected inbred lines have been back-crossed to determine possibilities of hybrid stock for commercial flower production use. A large-flowered pink strain has been developed which shows much promise as a winter-blooming greenhouse variety.

Complete information and results on hereditary phases of the breeding work on this project have been published as Massachusetts Agricultural Experiment Station Bulletin 400, February, 1943.



## DEPARTMENT OF FOOD TECHNOLOGY

F. P. Griffiths in Charge

**Cranberry Research.** (W. B. Esselen, Jr., H. J. Brunell, and F. P. Griffiths in cooperation with C. I. Gunness, Department of Engineering.) A drying temperature of 170°F. was found to be optimum for the dehydration of cranberries. Fresh cranberries should be either sliced or punctured prior to being dried in order to facilitate the removal of moisture. Sliced cranberries dried approximately 20 percent faster than did the punctured fruit. It was also observed that the dehydrated sliced cranberries rehydrated more rapidly than those which were punctured.

Approximately half of the ascorbic acid content of cranberries was destroyed during dehydration and practically all of it was lost when the product was stored for six months at room temperature (75°-80°F.) in sealed containers. An attractive and tasty cranberry sauce may be prepared from dehydrated cranberries.

**The Nutritive Value of Mushrooms.** (W. B. Esselen, Jr., W. H. Fitzpatrick, H. J. Brunell, and A. Filios.) Commercially grown mushrooms (*Agaricus campestris*) can be dehydrated so that on reconstruction and cooking they will compare favorably in flavor and appearance with fresh mushrooms. For dehydration it is recommended that the mushrooms be thoroughly cleaned in cold water, cut into pieces, blanched in steam for 2 minutes and 15 seconds and dried at a temperature of 145°-150°F. to a moisture content of 5 percent or below. The dehydrated mushrooms should be packaged in moistureproof containers and stored at a temperature of 75° or lower.

Fresh mushrooms are a very good source of riboflavin and nicotinic acid. The thiamine, riboflavin, and nicotinic acid of mushrooms are quite stable during dehydration and storage of the dried product.

The quick freezing of mushrooms was found to yield a satisfactory and flavorful product in which thiamine, riboflavin, and nicotinic acid were well retained.

When mushrooms (*Agaricus campestris*) were fed as the sole source of protein to white rats, they survived and grew, although not to the same extent as did rats which were fed casein or soybean meal. From the results of animal feeding experiments it was concluded that all of the essential amino acids are present in mushrooms but in lower concentrations than are found in casein. Chemical analyses showed that about 63 percent of the total nitrogen of mushrooms is in the form of a protein.

By means of chemical tests the mushroom protein was found to contain the following essential amino acids: phenylalanine, histidine, leucine, lysine, arginine, tryptophane, threonine. The essential amino acids which failed to give positive tests were: valine, isoleucine, methionine. However, that these three essential amino acids were also present was borne out by the animal feeding trials.

**Glass Container Research.** (W. B. Esselen, Jr., J. E. W. McConnell, J. J. Powers, R. G. Tischer, N. Guggenberg, G. J. Yourga, R. Woodward, and M. A. Ewing.) In studies of the keeping quality of packaged edible oils (corn and cottonseed oils), a number of chemical and physical tests for the detection and evaluation of rancidity have been investigated. The only practical method available at present for the determination of rancidity in oils stored in sealed containers is an evaluation of the oils by organoleptic means.

Of many antioxidants tested with corn and cottonseed oils, catalase and the palmitic acid ester of ascorbic acid appear to be the most promising. Gum guaiac and nordihydroguaiaretic acid have been reported as being satisfactory anti-

oxidants for lard; but these compounds, while possessing antioxidant powers, imparted an objectionable off-flavor to corn and cottonseed oils. In using antioxidants with edible oils it is important that the product be fresh and in good condition to start with; otherwise, much of the effectiveness of added antioxidants it is lost.

Amber glass bottles were found to be satisfactory as containers for liquid edible oils when stored under normal commercial conditions, and also convenient from the standpoint of use by the consumer.

Preliminary results indicate that riboflavin is quite stable during the canning and processing of vegetables. In such products as cut asparagus and cut green beans, there is a marked tendency for the riboflavin to leach out of the product into the brine. Thus if the brine were discarded when the can was opened, much of the riboflavin would be lost.

The carotene content of such vegetables as asparagus, green beans, corn, and peas was found to be very stable during canning and subsequent storage of the canned products in both glass and metal containers. Storage in bright sunlight for prolonged periods of time appeared to have no significant effect on the carotene content of glass-packed vegetables.

Thirteen different types of commercial and home-canning glass and metal containers were compared for their effect on the stability of the ascorbic acid in canned tomato juice. The loss of ascorbic acid during eight months' storage varied from approximately 35 to 50 percent, depending upon the type of container. In general, vacuum-sealed, commercial-type glass containers, plain tin cans, and home-canning jars sealed with two-piece metal lids were found to be superior from the standpoint of ascorbic acid retention in canned tomato juice. The differences observed in the different kinds of containers appear to be due largely to the amount of oxygen in the headspace and dissolved in the juice during processing and storage.

D-iso ascorbic acid proved satisfactory as an antioxidant for preventing the discoloration of freshly peeled peaches and pears, home-canned peaches and pears, and tomato catsup. In working with pure solutions, d-iso ascorbic acid was oxidized more rapidly than l-ascorbic acid (vitamin C). D-iso ascorbic acid was preferentially oxidized when used as an antioxidant for l-ascorbic acid and may be considered a good antioxidant for the latter substance. When these theoretical findings were applied to glass-packed tomato juice, none of the original l-ascorbic acid was lost, even under severe storage conditions, when small amounts of d-iso ascorbic acid had been added to the bottled juice. In addition to preventing a loss of l-ascorbic acid, the added d-iso ascorbic acid also prevented the juice from darkening when stored at high temperatures, and the juice maintained its original fresh flavor. For practical purposes, it would appear that, for optimum effectiveness, d-iso ascorbic acid should be added to tomato juice in amounts equivalent to 25 to 30 milligrams per pint.

Oxidation-reduction potential studies have tended to confirm the finding that d-iso ascorbic acid is an antioxidant for l-ascorbic acid, itself an antioxidant. The superior antioxidant properties of d-iso ascorbic acid over l-ascorbic acid seem to be correlated with the greater poisoning action of d-iso ascorbic acid, rather than with their respective redox potentials. Citrate-buffer ascorbic-acid packs were put up in plain tin cans and in commercial all-glass jars and stored at 70°F. and at 100°-110°F. The eventual ascorbic acid loss was the same in both types of containers stored at 100°-110°F., although the rate of loss was initially greater in the glass container. The potential of the tin-packed solution was lower than that of the glass-packed. In general the packs stored at 70°F. evidenced the same changes, except that slightly less ascorbic acid was lost in the tin container

(the test period has not been completed yet). The redox potentials of hot-break tomato juice packaged in plain tin cans, in commercial glass jars with metal lids, and in commercial all-glass jars and stored at 70°F. are being investigated. As with the citrate-buffer ascorbic-acid packs the tomato juice packed in plain tin cans showed a lower potential, but the difference in potential between the tin container and the two glass containers was much less than with the citrate-buffer ascorbic-acid packs. Differences in ascorbic acid content were almost insignificant. Flavor changes could not be correlated with redox potential.

A survey of spoilage encountered by home canners in Massachusetts in 1942 indicated that 293 families who canned a total of 73,393 jars encountered approximately 2 percent spoilage. The amount of spoilage is not considered excessive in view of the many variables encountered in home canning at the present time. In the laboratory examination of home canned foods, bacteriological culture tests were found to be the most reliable criterion of spoilage. As represented by this investigation it would appear that about three-fourths of home-canning spoilage is due to understerilization and one-fourth to improper sealing. The boiling water bath method of processing is not adequate to destroy certain types of bacteria encountered in the home canning of low acid vegetables. While a pressure canner correctly used is satisfactory for processing, understerilization may result if it is mis-used. From experimental evidence it would appear that home-canning process times at 240°F. (10 pounds pressure) as recommended at present may be more severe than are necessary and that in many cases they might be reduced. However, before any general recommendations are made, more experimental work must be done and careful consideration given to the many variables involved.

Experimental data indicate that many of the directions provided for home canning in pressure canners do not allow for sufficient venting and in some instances might contribute to underprocessing. A venting time of at least 10 minutes is to be recommended for pressure canners of the size commonly used for home canning.

A comprehensive study has been made of different types of glass containers and jar seals available for home canning under war-time conditions, and directions for their use were made available. Although some difficulties have been reported in the use of jars and seals, it is evident that much of the trouble was caused by the improper use of satisfactory equipment. Jar rings and seals made of synthetic and reclaimed rubber have given very good results from the standpoint of making an original seal and also of maintaining it during the storage life of the canned product.

**Comparison of Canning, Freezing, Dehydrating, and Salting as Methods of Home Food Preservation.** (W. B. Esselen, Jr., C. Dubord, and F. P. Griffiths.) Four varieties of snap beans, two varieties of cabbage and carrots, and one variety of sweet corn at two different stages of maturity were preserved by four home methods: canning, freezing, dehydrating, and salting. The preserved products were stored for six months and changes in their ascorbic acid content, palatability, flavor, texture, and color were observed and compared. Freezing appeared to yield the most acceptable product, followed by canning and dehydration. The salted products, with the exception of sauerkraut, were unsatisfactory.

On a basis of the final cooked ready-to-serve product, the total losses of ascorbic acid (referred to the fresh product) amounted to 85-95 percent in both the canned and frozen vegetables. The dehydrated vegetables maintained their quality to a high degree during three months' storage at room temperature (75°-80°F.), but after six months a definite deterioration in flavor was observed.



**Home Dehydration.** (W. B. Esselen, Jr., S. G. Davis, M. A. Ewing, and F. P. Griffiths.) A method has been devised for evaluating the performance of home dehydrators and has been used as a basis for setting up minimum performance standards. For this method of food preservation an electric dehydrator with forced air circulation and thermostat is recommended. Properly designed natural draft dehydrators may be used. In general, oven drying is least satisfactory because of the difficulty in controlling oven temperatures, the temperature variation in different parts of many ovens, and the frequency with which the trays must be rotated and shifted.

The following fruits and vegetables yielded a satisfactory product when preserved by recommended methods of home dehydration: apples, cranberries, peaches, pears, blue plums, red plums, green and red cabbage, beets, green beans, spinach, kale, baked beans, green and red peppers, broccoli, white potatoes, baked potatoes, and mushrooms. Foods dehydrated at home should be dried to a moisture content of below 5 percent, packaged in moistureproof containers, and stored at as low a temperature as possible.

**Dehydration of Foods in Atmospheres other than Air.** (F. P. Griffiths and R. E. Morse.) The dehydration of vegetables in atmospheres of methane or natural gas, carbon dioxide, and nitrogen, versus air was investigated. Methane or natural gas dehydration was effective in preventing losses of ascorbic acid during dehydration and did not produce off-flavors in the reconstituted foods. Storage of dehydrated foods in gas atmospheres was effective in retarding ascorbic acid losses and deterioration in quality when such foods were stored at room temperature (75°–80°F.). At elevated storage temperatures (110°–120°), less protection was noted and the quality deteriorated rapidly.

**Nutritive Value of Fishery Products.** (F. P. Griffiths and R. E. Morse in cooperation with R. T. Parkhurst of the Poultry Department.) Work was done on the dehydration and nutritive quality of starfish meal for use in poultry feeding. Starfish can be readily ground and dehydrated. The meal contained protein of high quality and a large amount of minerals. Chicks fed up to 8 percent starfish meal grew well and utilized the protein as efficiently as control groups fed equivalent amounts of fish and crab meals.

**Red Squill Research.** (L. R. Parkinson and F. P. Griffiths.) Under war-time conditions it has been increasingly difficult to obtain red squill (a raticide) of high toxic potency. Work carried on during the past year indicates that it may be possible to concentrate the toxic principle of red squill in order to provide a raticide of satisfactory killing powers.

**Vitamin D Milk Investigations.** (L. R. Parkinson and F. P. Griffiths.) During the past year approximately 150 samples of commercially produced milk have been assayed in order to check the efficacy of various methods of vitamin D fortification in providing a milk of desired vitamin D content. All samples tested were satisfactory and the results indicated that the methods of vitamin D fortification of milk can be relied upon to produce a satisfactory product.

**Fortification of Apple Juice Concentrate with Ascorbic Acid.** (F. P. Griffiths, M. J. Garvey, and J. J. Powers.) Fortification of canned apple juice with ascorbic acid has been practiced in Canada for some time. Because fresh citrus fruits are not always available and are often high priced and because canned citrus juices are restricted under point rationing, the practicality of administering ascorbic acid to infants using apple juice concentrate as a carrier was studied.



Fresh apple juice was practically neutralized and concentrated six - to seven-fold. (If the juice was to be concentrated more than six-fold, it was de-pectinated before concentration to avoid jellying.) The hot concentrate was filled into gallon jugs to which had been added approximately one-half ounce of synthetic ascorbic acid. The added ascorbic acid very decidedly lightened the color of the concentrate and thereby improved its appearance greatly. Over a three months' storage period only a minor loss of vitamin C was noted. When the concentrate was diluted to its original volume for use, the antioxygenic effect of the added vitamin C on the color was still evident, although, of course, to a much less degree.

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## DEPARTMENT OF HOME ECONOMICS NUTRITION

Julia O. Holmes in Charge

### The Effect of Institutional Cooking Methods on the Vitamin Content of Foods.

*I. The Thiamine and Ascorbic Acid Content of Potatoes.* (A. W. Wertz and C. Edith Weir.) The potatoes were of the Green Mountain variety, grown in the Connecticut Valley, and were obtained from the college dining hall which served 750 Army Air Corps cadets. They were sampled at the following stages: (1) pared, (2) soaked 6 hours, (3) steamed one hour at 225°F., (4) mashed, (5) steamed and held in a steam oven 1½ hours at 157°F., and (6) mashed and held for 1½ hours at 157°F.

Of the total thiamine, 5 percent was lost during soaking, 15 percent during steam cooking, and 5 percent during the 1½ hour holding period between cooking and serving. Mashing did not appear to destroy thiamine. Of the vitamin C, none was lost during soaking, 54 percent was destroyed during steam cooking, 20 percent during mashing, and 10 percent during the 1½ hour holding period. The over-all loss in the mashed potato held 1½ hours before serving was 88 percent.

On the basis of the data obtained in the study, it is of interest to estimate the value of the potato in relation to man's requirement for thiamine and ascorbic acid, using the amounts of potatoes suggested by the Bureau of Home Economics for a low cost, a moderate cost, and a liberal diet for a very active man; i.e., 1.1, 0.9, and 0.9 pounds daily. Thus the whole or the mashed potatoes would have contributed 16, 13, and 13 percent respectively of the daily requirement for thiamine. The whole potato held 1½ hours before serving would have contributed 25, 21 and 21 percent respectively of the 75 mg. allowance for ascorbic acid, whereas the potato mashed and held 1½ hours before serving would have supplied only 11, 9, and 9 percent of the allowance. Had the potatoes been eaten immediately at the end of the steam-cooking period approximately 1/3 of the daily allowance would have been supplied by the above quantities of potatoes. The individual who consumes no more than an average-size portion of potatoes, cooked and mashed in large quantity, should probably discount the potato entirely as a source of ascorbic acid.

*II. The Losses of Certain Vitamins in Beans.* (A. W. Wertz, B. V. McKey, K. O. Esselen, E. Fuller, and J. O. Holmes.) The beans used in this study were obtained from the Massachusetts State College dining hall which served approximately 750 Army Air Corps cadets. This food was selected because of the frequency with which baked beans appear, not only for these cadets but also in many New England institutions and restaurants. Moreover, the bean is reputed

to be a good source of the B-vitamins. The beans were analyzed (1) raw, (2) soaked, and (3) baked, following the addition to the parboiled beans of a mixture of molasses, tomato puree, and brown sugar. The analyses included thiamine, riboflavin, nicotinic acid, and pantothenic acid.

The soaked and drained beans had the same thiamine content as the raw dried beans. During the baking, however, three-fourths of the original content of thiamine in the beans-molasses mixture was destroyed. Raw beans are rich in thiamine; one-third cup of dried beans, equivalent to 1 cup of baked beans, contains approximately 0.4 mg. of thiamine or 22 percent of a moderately active man's daily thiamine allowance of 1.8 mg. One cup of baked beans, however, would contribute only .11 mg. or 6 percent of the daily allowance.

Riboflavin was not lost during either the soaking or the baking of the beans. In addition, the molasses-tomato-sugar mixture, added before baking, contributed almost as much of the vitamin as was in the raw bean. The baked beans, therefore, were richer in riboflavin than the raw beans. Even so, the baked beans were an extremely poor source of riboflavin; one cup of them would have supplied only 0.16 mg. or 0.6 percent of a moderately active man's daily allowance.

Approximately 11 percent of the nicotinic acid was lost during the soaking of the beans and another 11 percent during the baking. The baked beans were only a fair source of nicotinic acid, one cup contributing 1.2 mg. or 7 percent of a moderately active man's allowance.

During the soaking of the beans approximately 20 percent of their pantothenic acid was lost. At the end of baking, the beans had 18 percent less pantothenic acid than did the raw beans, although considerable of this vitamin was added in the molasses mixture. The baked beans contained 0.15 mg. pantothenic acid per cup.

*III. The Losses of Certain Vitamins in Fish.* (A. W. Wertz, B. V. McKey, K. O. Esselen, E. Fuller, and J. O. Holmes.) The fish were cut into serving portions, rolled in crumbs, seasoned, and baked 30-40 minutes at 450°F. When the fish were browned, moisture was added in the form of water, milk, or tomato puree in portions of 1 pint to 12 to 15 pounds of fish.

Forty-four percent of the thiamine was lost in the baking process. Some of the cooked fish were a poor source of thiamine, cod being the poorest. Cod, haddock, cusk, and pollock were found to contain between .011 and .062 and mackerel between 0.14 and 0.21 mg. of thiamine per one-fourth-pound serving portion. Whereas the mackerel would supply approximately 10 percent of a man's requirement for thiamine, those species related to the cod would supply only from 0.6 to 3 percent.

Of the 18 lots of fish studied, 11 lost riboflavin during baking, the average loss for these 11 approximating 28 percent. The mackerel contained more riboflavin, 0.5 mg. per 4-ounce serving, than did cod, cusk, haddock, pollock, and flounder, which averaged 0.12 mg. riboflavin per serving. The mackerel, in contrast to the other fish studied, is therefore a good source of riboflavin, and a moderate-sized serving of it will supply approximately one-fifth of the day's requirements for this vitamin.

During the baking process the average loss in nicotinic acid in fish was 29 percent. As was true for thiamine and riboflavin, mackerel contained appreciably more nicotinic acid than did the other species studied; 9.1 mg. per 4-ounce serving in contrast to 2.5 mg. for the others. Since the daily allowance of nicotinic acid for a moderately active man is 18 mg., it is obvious that a small serving of mackerel will supply half of it.

One-third of the pantothenic acid in the raw fish was destroyed during baking. In a 4-ounce serving of baked fish, mackerel had the largest quantity of this vitamin (4.6 mg.), flounder contained 2.4 mg., and those species related to the cod contained the least (1.7 mg.).

**Dietary Factors Influencing Tooth Decay.** (J. O. Holmes and L. R. Parkinson.) Massachusetts leads all other states in the incidence of tooth decay. Since human experience teaches that tooth decay can be inhibited by diet, this study was undertaken in an attempt to shed light on the dietary factors concerned. Rats were used as the experimental animals. They were fed a diet composed predominantly of coarsely ground corn. The hard particles cause fracturing of the teeth and enamel thereby presumably providing a surface susceptible to decay. In this respect the initiation of tooth decay in the rat apparently is not comparable to that in man. In addition to the basal diet various substances were fed; namely, cod-liver oil, sodium fluoride, vitamin K, the amino acid, cystine, a solubilized liver fraction containing several vitamins, the filtrate fraction of the vitamin-B complex containing several of the B vitamins, and the following individual components of the vitamin-B complex, choline, folic acid, para amino benzoic acid, biotin, pantothenic acid and inositol. Judged by the number of teeth wholly or partially missing, all of the diets allowed tooth destruction. However, fewer teeth were missing in the rats fed either fluorine or the filtrate fraction of the vitamin-B complex. The diet conducive to the greatest destruction of the teeth was the one containing choline. Examination of the teeth for small cavities has not been made as yet; such an examination is necessary before final conclusions can be made.

**Calcification of Eggshell.** (Marie S. Gutowska and Carl A. Mitchell.) Since poultrymen occasionally find soft-shell eggs, this study was undertaken to determine the factors concerned with the deposition of calcium carbonate onto the eggshell membrane. Phosphatase, the enzyme responsible for calcification of bone, apparently plays no role here. Proof that the enzyme concerned is carbonic anhydrase was obtained from two sources: (1) from data showing a higher content of this enzyme in the shell gland of layers than of non-layers and of layers of strong-shell eggs than of layers of soft-shell eggs; (2) from data obtained by injecting into laying hens sulfanilamide, which has an inhibiting effect on carbonic anhydrase activity. By varying the dosage, shells were produced with varying degrees of thickness, ranging from a thin soft membrane to a thick, chalky shell (see cut). The thickness of the shell varied directly with the level of carbonic anhydrase in the shell gland following the sulfanilamide injections. The carbonic anhydrase in the shell gland apparently acts as a catalyst in releasing from the blood carbonate ions, which, in turn, unite with the calcium of the blood to form calcium carbonate. The developing egg probably does not play an active role; its slight alkalinity provides a favorable environment for the precipitation of the calcium carbonate onto the membrane as the egg passes through the shell gland.



Effect of Sulfanilamide Injection on the Calcification of the Eggshell.

(The eggs are shown from their blunt end.)

- Unnumbered--Smooth egg before injection.
- 1--soft-shelled egg 1 day after injection.
- 2--rough-shelled egg 2 days after injection.
- 3--smooth-shelled egg 5 days after injection.



## DEPARTMENT OF HORTICULTURE

R. A. Van Meter in Charge

**Factors Influencing the Rapidity of Growth of Nursery Stock.** (C. J. Gilgut, Waltham.)

*Evergreens.* Carolina hemlock and Canada hemlock grew better when given light applications of complete fertilizer than when given heavy applications. More new growth was obtained from 1/3 to 1/2 ton per acre of 5-8-7 broadcast among the plants than from one ton or more used in the same way. The heavier application, in many cases, actually injured the plants and injury was in the nature of stunting, poor growth, or dead tops. Mixed fertilizers such as 10-8-7 which contain a high percentage of nitrogen produced no more growth than did the 5-8-7 when used at the same rate, and sodium nitrate at 300 pounds per acre caused some injury, indicating that hemlocks do not need much nitrogen.

*Deciduous Shrubs.* Rooted cuttings of the hybrid lilac *Ludwig Spaeth* lined out in the field and given fertilizer treatments grew to salable size by the end of the second season as did those which received no fertilizer. There was no significant difference in growth and thriftiness of the plants which received fertilizer and those which did not. Fertilizing lilacs in the nursery to speed up growth is not advisable, especially when they are grown in a fairly good soil.

**Factors Influencing the Hardiness of Evergreens.** (C. J. Gilgut, Waltham.) Conditions favorable to winter injury of ornamental woody plants were present in the winters of 1942-43 and 1943-44 and offered a fine opportunity to determine the effect of cultural and fertilizing practices on winter hardiness of *Taxus cuspidata*, *Taxus canadensis stricta*, and *Taxus baccata repandens*.

The winter of 1942-43 provided the low temperatures which are considered one of the causes of winter injury. Several times the temperature went down to -15°F. and in addition there were prolonged periods of cold. During most of the winter there was a good cover of snow.

The winter of 1943-44 was quite different in that it was much milder and there was very little snow. The temperature went down to -3°F. only twice and even then for only a few hours. Most of the time it was well above zero, and from February on there were warm spells with strong drying winds—a condition which causes much winter drying, especially of evergreens.

During both winters the amount of injury was slight on the plants in the experiment. There was as much injury on plants which grew slowly and produced hard growth as on those which were stimulated with nitrates and fertilizers and produced soft growth.

**Study of Herbaceous Perennial Material.** (C. J. Gilgut, Waltham.) The herbaceous perennial test garden continues to be popular with visitors some of whom visit regularly, as often as twice a week throughout the summer. To the plants of recognized garden value and easy culture, new introductions and reintroductions of older plants little known to the general public are constantly being added. During the past summer 78 such new acquisitions were placed in the garden to determine their cultural requirements, habits of growth, garden value, and hardiness under the climatic conditions of this region. The collection now consists of about 1680 plants. Reports of the behavior of these plants are available to nurserymen and plantsmen, and are of assistance to them in deciding whether a new introduction is worth disseminating and what plants can best be dropped from catalogues.

The winter of 1943-44 was unusually severe on perennial plants many of which were killed in spite of a hay mulch. Severe damage occurred on Iris, particularly the hybrids with California parentage, and on hybrid Chrysanthemums of which more than 50 percent were killed outright.

## DEPARTMENT OF OLERICULTURE

G. B. Snyder in Charge

**Spraying Tomato Flowers with a Growth Hormone in the Greenhouse.** (W. H. Lachman and G. B. Snyder.) Tomato flowers of the Waltham Forcing variety were sprayed during the winter months with a solution of orthochlorophenoxypionic acid, 50 mg. per liter of water. The effect of this material was marked, for the ovaries of the sprayed flowers were twice as large as those of the unsprayed flowers at the end of three days. The fruits from the sprayed flowers were seedless for the most part, and the yield was markedly greater from these clusters than from the clusters of unsprayed flowers.

**The Carotene Content of Carrots.** (W. H. Lachman.) Seven varieties of carrots were analyzed for carotene during various stages of maturity as well as after they had been in cold storage at 32°F. for five months. Each of the varieties increased in carotene content with each successive sampling up to the time of harvest, which was November 1, 1943. The remaining roots were placed in a cold storage room where they were kept until April 1, 1944. The roots were again analyzed for carotene and the varieties were all found to be appreciably higher in carotene than before they were placed in cold storage.

**The Effect of Mulching Staked and Pruned Tomatoes.** (W. H. Lachman and G. B. Snyder.) Mulches of straw, manure, and sugar cane fiber were applied to the soil of plots in which staked and pruned tomatoes were grown. The mulches entirely prevented weed growth so that cultivation of the plots was not necessary. The mulches have increased the moisture-holding capacity as well as the organic matter content of the soil over the plots without any treatment. The yields and quality of fruit from these plots, however, do not show any significant differences. Cracking of the fruit has been largely responsible for lowering its quality, but it is evident that mulching has little effect on this factor.

**Asparagus Investigations.** (Robert E. Young, Waltham.) The work with asparagus consists of a breeding project in which individual production records have been obtained from 450 plants. This group of plants is made up of five selected strains from previous yield trials and one commercial variety. This is the fifth year that these plants have been harvested. The two best strains continue to produce about twice as much weight as the commercial variety.

There were some changes during the year and the yields were not as great as last year, the decrease amounting to 18 percent. The reduction in yield was not uniform for the six lots. For the highest producing strains the loss was 19.0 percent, and for the next highest 24.7 percent. The commercial variety, which was one of the poorest producers, lost only 15 percent.

The lower yields obtained for the year were due almost entirely to a smaller spear size because the total number of spears produced was about the same as the year before.

There seemed to be considerable change in the behavior of individual plants. Of the 50 best producing plants in 1942 about half remained in that category

this year. Of the 50 best plants in 1943, half had increased their yield while the others yielded less than previously.

The rust disease which was so general in 1942, and had been increasing for the last few years, failed to show up even on the most susceptible plants.

**Vegetable Breeding for Improvement of Quality.** (Robert E. Young, Waltham.) During the year breeding work has been conducted with greenhouse cucumber, Summer Pascal celery, rutabaga, greenhouse lettuce, New York type lettuce, broccoli, carrot, and tomato. While progress has been made in developing strains of broccoli, carrot, and tomato better adapted locally, it is insufficient to justify detailed discussion.

*Greenhouse Cucumber.* The work of breeding a greenhouse cucumber has been projected along two lines. The first method has been to self-pollinate the best strains or varieties obtained from local growers. These strains originally varied considerably because the seed had always been mass-produced. Selfing has made them sufficiently uniform for extended trials with the growers.

In the second method of breeding, hybrids made by crossing these selfed lines were used. Yield trials with this material have been restricted by lack of greenhouse space. In the spring of 1943 the average yield of four hybrids over their respective parents was 11 percent. With better seed lines in 1944, the increase was 30 percent. Certain combinations of selfed lines were much better than others, such as hybrid M x A which was 35 percent better than the parents; A x H was 7 percent better; and H x W, 50 percent.

While it will take time to determine the proper combinations necessary for best yields for spring and fall, and under different types of pruning and training, the hybrid vigor is such as to make it desirable to place this material in the hands of growers for further testing. Moreover, the hybrids have produced an increase not only in yield but also in the percentage of No. 1 fruit, which is very important. To determine the best methods of producing hybrid seed, and the cost, has now become a part of this investigational work.

*Greenhouse Lettuce.* The crosses of Bel May X Cheshunt Early Giant were judged sufficiently uniform to be given a trial by growers before final fixing. The new variety has been named Waltham Early Forcing. In comparison with Bel-May it grows faster, has a darker green color, better development of the leaves on the bottom, and bolts to seed more slowly. Waltham Early Forcing plants are smaller than Bel-May, and the overlap of the leaves of the head is not so good.

Tests are now being conducted by growers in greenhouse and hotbed. The results of these tests will be used to determine whether the variety has sufficient merit to justify further work.

*Lettuce, New York Type.* (Cooperation with U. S. Bureau of Plant Industry.) The work with this crop has progressed to the point where two of the selections are ready for trial by growers. The first strain is one that has been selected for several years. It came originally from Dr. Whittaker of the U. S. Department of Agriculture, La Jolla, Calif., and is the same hybrid material from which Great Lakes was selected. Under our conditions the selection produced 90 percent marketable heads, as compared with 67 for the Great Lakes. There are some differences in the shape of head and character of the leaf but, in general, it resembles Great Lakes.

The second selection being made ready for trial is one from segregating material provided by Dr. Thompson of the U. S. Bureau of Plant Industry, Beltsville,



Md., and involves a cross between Cosbia and Imperial 847. It is a good green color, does not tipburn readily, and is slow bolting. The leaf type of this strain is quite different from most lettuce. The local adaptation value of these two strains can be determined only by large-scale plantings by growers.

*Summer Pascal Celery.* The results of a breeding program to improve Summer Pascal celery by selection of single plants have shown that this variety is so homozygous in most characters that the population of the single plants cannot be distinguished from each other. Therefore, any further changes which are desired in this variety must be made by hybridization.

In anticipation of this, crosses were made between Summer Pascal and Cornell No. 19, and the second generation was grown as a spring crop. Prolonged cool weather at setting time caused some seed stalk formation: 100 percent in Cornell No. 19, 30 percent in the hybrid, and none in Summer Pascal. The redistribution of the various characteristics in the hybrid was such as to provide plants with almost all the desired points, and seed is being obtained for further trials.

Summer Pascal celery when grown at the Waltham Field Station has been short, with a total height of 20 inches; but the distance from the base to the first joint of the leaf stalk is rather long, 8.3 inches. This compares with Golden Plume which is 22.3 inches tall and 7.11 inches to the first joint. Cornell No. 19 is rather tall, with plants 22.3 inches and 8.6 inches to the first joint. Many of the hybrid plants were 11 to 11.5 inches to the first joint with plants 22 to 23 inches tall. Increasing the length of the stalk without increasing the height of the plant produces heavier celery with a larger percentage edible.

*Rutabaga or Cape Turnip.* During the past two years three strains of rutabaga were sent out to selected growers in Bristol and Barnstable Counties for trial. As a result of these trials, growers in Bristol County have selected the No. 1 white rutabaga as being more desirable than any variety previously available. In that section there are large plantings of this crop, mostly of the white flesh type. Because of acceptance of the variety in that area, it has been named Bristol White. This variety has foliage similar to Macomber, a white or very light purple shoulder that is unusually smooth, a short neck, and very few roots on the side. The white shoulder and smooth skin are contributing factors for good market appearance. Bristol White was developed as a white shoulder segregate from a green shoulder, white flesh Cape turnip.

Another strain given trial at the same time as the Bristol White is one having yellow flesh and green shoulder instead of the usual purple. It has been named Waltham Yellow turnip, and is considered of sufficient merit to justify further trial in sections that grow the yellow flesh type. This also is a segregate out of a White Cape strain. The flesh is a light yellow color and growth is typical of the White Cape turnips.

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## DEPARTMENT OF POMOLOGY

R. A. Van Meter in Charge

**The Influence of Various Clonal Rootstocks on Apple Varieties.** (J. K. Shaw and L. Southwick.) The stock beds were continued and yielded a fair crop of rooted layers. Most of these were sold to nurserymen for establishing new stock beds. Dwarfing and semi-dwarfing rootstocks are in short supply and there is need for a substantial increase in establishing stock beds.



The orchard of 900 trees planted in 1939 has suffered from magnesium deficiency during the last three seasons. This is being corrected and at the present writing the trees are growing vigorously. Many of the trees bloomed in the spring of 1944, but the frost of May 19 ruined the crop except in the more elevated part of the orchard.

Trees on semi-dwarfing rootstocks are in demand by commercial growers who do not like tall trees. They will give acre yields equal to or higher than trees on seedling rootstocks, and growing and harvesting costs should be less.

One new cooperative orchard was planted in the spring of 1944.

**Lethal Incompatibilities Between Clonal Stocks and Varieties of Apples.** (J. K. Shaw and L. Southwick.) A paper reporting the results in 1943 appears in the Proceedings of the American Society for Horticultural Science, Volume 44. The combinations of the rootstock Spy 227 with various strains and varieties developed in the spring of 1944 as had been anticipated from their condition last fall. Shotwell Delicious, Paragon (Iowa strain), "Paragon L," Yates, and three strains of McIntosh are making normal growth; Blaxtayman is growing but is below normal; Stayman, Stamared, Winesap, Delicious, Starking, Richared, Golden Delicious, Arkansas (Mass. strain), Mammoth Black Twig (Iowa strain), Turley, Arkansas Black, and five strains of McIntosh including Blackmack are dead or dying. "Paragon L" is an unknown variety resembling but distinct from Arkansas and Paragon. A few Spy 227 stocks budded to strains that have failed, on which the bud failed to start, are now dead; while a few on which the bud of a successful strain failed to grow have put out new growth. Apparently the roots of Spy 227 budded to the "lethal" strains are dead or nearly so, and this root failure is the reason for the death or decline of the trees.

Winesap, Stayman, and one of the McIntosh strains, all of which fail on Spy 227, are growing vigorously on the two Spy 227 seedling clonal stocks, 227-2 and 227-12.

**Study of Bud Sports of the McIntosh Apple.** (J. K. Shaw and L. Southwick.) Several of the so-called bud sports fruited in 1943. These had all been selected on the basis of apparent variations of skin color of the apples. While slight differences in coloration were apparent, none were great enough to be of commercial significance. None of the distinctly striped strains fruited. This year's experience suggests that perhaps the selection of strains should be confined to the elimination of distinctly striped strains. Real evaluation of McIntosh strains awaits their performance in the orchard planted in 1941.

**The Genetic Composition of Peaches.** (J. S. Bailey and A. P. French.) Because of the severe winter of 1942-43, all peach buds were killed so that there was no crop and no field work could be done. It has been decided to terminate this project, and a final report is being prepared.

**Tree Characters of Fruit Varieties.** (J. K. Shaw, A. P. French, O. C. Roberts and L. Southwick.) New varieties are being grown in the nursery for study in order that we may be familiar with them when found in commercial nurseries in the course of the usual nursery inspection service. One nursery was inspected for the first time in 1943, and, as is usual, more misnamed trees were found than in nurseries that have been examined for several years. The Massachusetts Trueness-to-Name Inspection Service now examines a large proportion of the nursery fruit trees grown in the northeastern part of the country and the number of misnamed trees reaching growers is very small.

A bulletin on plum varieties has been published.



Forced Half Canes of Raspberry, showing that starting of top buds is due to polarity not to difference in resting condition.

Nature of Winter Hardiness in the Raspberry. (J. S. Bailey, A. P. French, and R. A. Van Meter.) Shoots of six varieties of raspberry, Latham, Chief, Marcy, Taylor, Milton, and Washington, were brought into the greenhouse at monthly intervals during the winter and forced, to determine the length of the rest period. It is very short, ending in late November for a tender variety like

Marcy, and in early December for a hardy variety like Latham or Chief. Some shoots of Marcy, when brought into the greenhouse in late November had very immature terminals with leaves still attached. The buds on these terminals were easily forced into growth, making it look as if they had never gone into the rest period.

The terminal buds of raspberry canes commonly start first. To check the possibility that this is caused by a difference in the resting condition of the buds on the tip and on the basal half of the cane, canes were cut in half and the two halves forced separately. The fact that the top buds on the terminal and basal halves started equally readily (see cut) showed that the starting of the terminal buds is due to polarity and not to differences in rest period.

In winters when minimum temperatures are not below normal, there may still be considerable winter injury as in the winter of 1943-44. To see whether this injury is due to drying out and could be prevented by waxing the canes, a section of a row of each of the six varieties named above was sprayed with Dowax in the late fall. In the spring there was no difference in the amount of winter injury on the waxed and unwaxed canes, nor were there any consistent differences in moisture content of the canes. However, it is difficult to maintain a good wax coating on the canes, particularly the larger ones, the bark of which tends to split and peel off.

Estimates were made in the spring of 1943 and 1944 of the amount of winter injury to red raspberries, expressed as percentage of the total cane length injured. Results were as follows:

Variety	Percent Injury		Variety	Percent Injury	
	1943	1944		1943	1944
Sunrise.....	0	10	Cuthbert.....	25	60
Tahoma.....	5	10	Taylor.....	28	13
Indian Summer....	5	5	Washington.....	30	31
Latham.....	9	8	Ohta.....	35	15
Ranere.....	10	16	Milton.....	44	18
Chief.....	11	6	Viking.....	45	70
Lloyd George.....	15	40	Marcy.....	68	63
Cayuga.....	20	5	Newburg.....	75	50

**Controlled-Atmosphere Storage of Apples.** (L. Southwick and O. C. Roberts, in cooperation with the Department of Engineering.)

1942-43 Season—The controlled-atmosphere storage room was filled (about 300 bushels) and closed on September 25, 1942. The oxygen was reduced to around 7 percent in two weeks' time, but it required seven weeks to reach 2 percent because of air leakage through the washer.

The McIntosh apples came out in fair to good condition on April 30, 1943. Although the characteristic aroma was lacking, as expected, the eating quality comprising firmness, crispness, juiciness, and flavor was superior to that of cold storage McIntosh. There is no doubt that the apples "kept" better and were less mature after 7 months in the controlled-atmosphere storage at 40°F. than similar apples in ordinary 32°F. cold storage. There was no regular storage scald but many apples were affected with a trouble which in appearance resembled soft scald but which probably was due to a lack of sufficient oxygen. On several occasions, and for periods of from one to several days, the oxygen level was below 2 percent and in two instances below 1 percent.

An experiment on the effect of date of harvest and pre-storage temperature following picking of McIntosh was conducted. Apples were harvested September 10, 15, and 21, and each picking was divided into three lots which were

stored at 32°, 40°, and 50°F. to September 25, when all were placed in the controlled-atmosphere storage. All apples in the experiment came from a single tree. The main conclusions from this experiment follow:

1. Ordinary scald was not a factor except on apples picked early and held at 50°F. until placed in the controlled-atmosphere storage. From 90 to 100 percent of these scalded severely, but wrapping with oiled paper wraps controlled scald almost perfectly.

2. The soft scald type of injury (probably due to low oxygen) was more prevalent on the later picked fruit and in any particular lot on the more highly colored apples. There was no significant relation between incidence of this injury and the pre-storage temperature. Wrapping had no effect.

3. Judged by pressure tests and ground color, all apples had reached approximately the same stage of maturity by May 5, 1943, except those picked on the 10th and 15th of September and held at 50°F. These were riper.

1943-44 *Season*—The room was filled and sealed on September 30 and opened on March 27. The majority of the McIntosh apples were in excellent condition when checked after removal. Only an occasional apple showed the low-oxygen injury that was so prevalent the previous year, as special care had been taken to keep the oxygen level from dropping below 2 percent for any length of time. To compare the firmness of apples from air and controlled-atmosphere storage, flesh pressure tests were made on samples from each lot before and after storage. The apples in each comparison were harvested from the same tree. Average figures for 16 lots were as follows: on October 14, 10.06 pounds; on March 28, controlled-atmosphere stored apples, 9.01 pounds, and cold storage apples, 8.17 pounds. In every comparison, the controlled-atmosphere apples were firmer according to this pressure test. This difference was readily apparent in handling the fruit. Although the characteristic McIntosh flavor was lacking, the controlled-atmosphere stored apples were more crisp and juicy and in better condition for marketing than those stored in the usual way. Golden Delicious apples likewise were in good condition. Cortland scalded badly. No oiled wraps or shredded paper were used on any of the apples.

**The Effect of Orchard Mulches on the Plant Nutrients in the Soil.** (J. K. Shaw in cooperation with the Chemistry Department.) Soil samples were collected as in previous years and the orchard treatment continued. Analysis of the soil samples awaits the restoration of personnel absent in the war effort.

**Blueberry Culture.** (J. S. Bailey.) In cooperation with Professor W. L. Doran of the Department of Botany, a propagation experiment was carried out in which softwood cuttings of the variety Rubel were treated with various root-inducing substances. Several of these speeded rooting. Indolepropionic acid seemed particularly promising. The results of this work were reported in Massachusetts Agricultural Experiment Station Bulletin 410.

Until the summer of 1943, mummy berry had appeared only on a bush here and there in the Experiment Station blueberry planting. In 1943 considerably more appeared, enough to suggest that it may become a problem. An estimate of its severity on several varieties was made, using 0 for no infection and 10 for the heaviest. Results were as follows:

Wareham	—10	Cabot	— 5	Pemberton	— 2
Concord	— 9	Pioneer	— 3	Stanley	— 2
Rancocas	— 8	Rubel	— 3	Jersey	— 2
Scammell	— 6				



In spite of the severe cold during the winter of 1942-43, blueberries were not severely injured. There was some injury to Cabot, both to the buds and wood. Injury to fruit buds of other varieties was very light. In spite of the cold winter, the 1.4 acres yielded 3800 quarts in 1943. The winter of 1943-44, although not extremely cold, was much harder on the blueberry plants; in fact, injury was the worst it has ever been at Amherst. A few plants were killed to the ground and a very considerable number had half or more of the wood killed. Injury was worst on stems 4 years old and older and on tender tips. There was little injury to vigorous young stems 3 years old or less. Also, it was noticeable that vigorous young shoots from stems 4 years old or older were injured much worse than the same type of growth from stems 3 years old or less. Injury to varieties from worst to least was as follows: Rubel, Number 73, Cabot, Scammell, Pioneer, Wareham, Pemberton, Stanley, Concord, Jersey. It was very unusual to have Rubel injured so badly, for this has been considered one of our most hardy varieties.

A severe frost on May 19, 1944, killed some tender tips of shoots and the margins of young leaves, and reduced the crop by perhaps 10 percent, although in many cases it was difficult to tell whether failure of berries to develop was due to winter injury or to the frost. It is estimated the 1944 crop will not exceed 20 percent of the 1943 crop.

Jersey continues to look more promising as a commercial variety. The fruit is large and very attractive, the quality is excellent if the berries are allowed to ripen, yields are high, and the bushes are very vigorous and appear to be winter hardy.

Wareham continues to produce large crops of large, fine-flavored berries, and ripens part of its crop after other varieties are all picked. However, it has two weaknesses which are serious enough to make its value as a commercial berry questionable: the berries crack badly after rains, and it appears to be very susceptible to mummy berry.

Some budded branches of a few U.S.D.A. seedlings produced a few berries for the first time in 1943. The fruit of F-72 is dark like Wareham but much larger. It is a little tart for eating fresh, but should make a good pie berry, for which purpose it was selected. It gives promise of being a heavy producer but had some mummy berry. It ripens late. R-86 has very attractive berries of a good blue color. Flavor is excellent, but size is not outstanding. It ripens late. U-85 is also late ripening. The berries are very large and attractive, but not quite so good in flavor as Pemberton. V-20 has berries as large as Pemberton or larger. Flavor is excellent when the berries are well ripened. The scar is large. It ripens late. GN-87 looked promising again in 1943. The berries are large, attractive, and of good flavor. The clusters were larger than previously, and, as a consequence, the berries were somewhat smaller. It promises to be a heavy yielder. Two possible weaknesses appeared: a large watery scar and some mummy berry.

**Nutrition of the High-bush Blueberry, Especially in Relation to Soil Reaction.** (J. S. Bailey.) An experiment was set up in 1941 to test the effect of horse, cow, and poultry manure on cultivated blueberries. So far there has been no evidence of the toxic effect supposed to follow the use of manure. There was no significant difference in yield or size of berries which could be attributed to the kind of manure. A report of this work will appear in Volume 44 of the Proceedings of the American Society for Horticultural Science.

The difficulty of curing chlorosis by iron sprays or soil treatments indicates that some other element, perhaps potash, may be lacking. This is being investigated.

**Preharvest Dropping of Apples.** (L. Southwick.) Comparative tests with sprays and dusts for controlling the preharvest drop of apples were conducted in the late summer and fall of 1943. For the first time, dusts were used which contained higher percentages of active ingredients than the usual commercial dusts. The "regular" strength dusts were prepared so that one pound of dust was equivalent to ten gallons of a standard (.001 percent) spray in amount of active ingredient, while most of the more concentrated dusts used contained twice the amount. Standard and double strength sprays were included in the tests, and both dusts and sprays were used in single and in duplicate applications.

The fairly uniform success from all treatments in lessening preharvest drop of McIntosh was not entirely consistent with previous results which have shown better success with stronger sprays as well as with duplicate applications. Wider differences might have appeared had the harvest been delayed. Nevertheless, some of the data showed a slight trend toward better drop control with the double strength and the duplicate applications of both dust and spray. Therefore, further work is planned for the 1944 season. A report of the 1943 experiments will appear in Volume 44 of the Proceedings of the American Society for Horticultural Science.

Five new chemical compounds were tried in small-scale tests to determine their possible usefulness in controlling preharvest fruit drop. However, none of these materials in spray applications was comparable to naphthalene acetic acid in effectiveness.

**Beach Plum Culture.** (J. S. Bailey.) A cooperative experiment was carried out with W. L. Doran of the Department of Botany on the propagation of beach plums by softwood cuttings. See the report of this work given on page 20.

As a result of the experience in 1942, the spray program was modified to get better control of the various diseases and insects. Slightly better results were obtained but the control of plum gouger was still poor. Careful search was made during the blooming seasons of 1942, '43, and '44, but no gougers were found. It is evident that this insect does not appear as early as had been reported. Limited preliminary tests of cryolite and of calcium arsenate sprays on beach plums were made in Amherst in the spring and early summer of 1944. No burning of the foliage has as yet resulted from the use of either material.

The failure of nearly the entire beach plum crop on the Cape in both 1941 and 1942 made it difficult to evaluate the effects of fertilizer treatments. Judging by the appearance of the plants and set of fruit (which later dropped off because of dry weather), a single application of 400 pounds per acre of a 5-6-4 cranberry fertilizer was better than the same amount split into 3 applications or than no fertilizer, although this application is probably too light to be very effective. Cottonseed meal used alone in 1943 gave slight evidence of benefit.

Because of lack of trained personnel to supervise the work, these experiments had to be discontinued in 1944. In their place outlines were prepared for grower cooperative experiments. These were distributed through the office of the County Agent, Mr. Bertram Tomlinson.

A more complete report of the beach plum work is in preparation.

**Magnesium Deficiency in Massachusetts Apple Orchards.** (L. Southwick.) It is now recognized that magnesium deficiency in apple orchards in Massachusetts is not limited to a few cases. Since the deficiency was positively diagnosed in 1942, it has been reported from most orchard sections in the state. Growth records in our young clonal stock orchard indicate the seriousness of this nutrient deficiency. The average increase in trunk cross-sectional area over a 4-year

period shows that growth has been negatively correlated with severity of leaf scorch which is a principal symptom of magnesium deficiency.

Certain treatments designed to correct the deficiency were started in the fall of 1942 and continued in 1943. Four early-season spray applications of 2 per cent magnesium sulfate (16 pounds of Epsom salts per 100 gallons of water) on young trees of several varieties gave commercial control of foliage scorch in 1943. Applications were made at approximately the dates for the pink, calyx, first cover, and second cover sprays.

Soil applications of Epsom salts, magnesium oxide, and kieserite, made in 1942, benefited young mulched trees in 1943 but not older bearing trees growing in sod. These materials were mostly broadcast on the soil under the affected trees in quantities varying from 5 to 15 pounds per tree. Magnesium limestone applied in amounts up to 50 pounds per tree was not effective. Other experiments likewise indicate that benefits from surface-applied limestone will be comparatively slow. Nevertheless, an important aspect of the use of magnesium limestone is its beneficial effect in reducing soil acidity as well as its capacity to prolong the effectiveness of the more soluble magnesium materials. A full report of the experiments will be published in Volume 44 of the Proceedings of the American Society for Horticultural Science.

**Thinning Apples and Peaches with Caustic Sprays.** (J. K. Shaw.) Experiments in thinning with caustic sprays were started in the spring of 1944 on Wealthy, Duchess, and McIntosh, also on several varieties of peaches. Comparisons were made of concentrations of from 1 to 3 pints of Elgetol in 100 gallons, of one and two applications, and of time of application as related to the development of the flowers. It is too early to draw final conclusions, but some preliminary statements may be ventured.

A spray of 2 pints to 100 gallons took off all or nearly all the fruits on moderately vigorous McIntosh.

Duchess trees were sprayed once, 2 pints in 100 gallons, on May 9, May 11, or May 12. All sprays were more or less successful. The spray on May 11, when practically all spur flowers were open and a few petals were falling, gave the best results. These trees need little or no further thinning. Wealthy trees, treated similarly on the same dates, when the flowers were less advanced, show no apparent results from the early spray and only partial thinning from the medium and late sprays.

Concentrations of from 1 to 3 pints in 100 gallons applied once (May 12) or twice (May 12 and 15) to Wealthy in another orchard gave varied results. Only the double spray, 2 pints in 100 gallons, seems to have thinned the fruits effectively. The weaker and the single sprays seem to have had more or less effect on the weaker trees, which are somewhat lacking in nitrogen, but all these trees require further thinning. Nearly all sprays were less effective on stronger trees which have been heavily mulched.

These preliminary observations suggest that McIntosh is easily thinned while Wealthy requires severe treatment, especially when the trees are vigorous and high in nitrogen. Duchess takes an intermediate position. Perhaps strong or double sprays should be used on trees known to have the habit of setting heavily, and weaker sprays on trees known to set only moderately.

Injury to the trees was less than expected. Measured by what is expected from pesticide sprays, it was rather severe; but the trees now look all right and perhaps the spray injury weakened the trees less than would the setting of an excessive crop. All these trees (except the McIntosh) have been distinctly biennial. Whether any of them will set a crop next year remains to be seen.



Sprays of 1 and 2 pints in 100 gallons applied to peach trees in full bloom were only partially effective. All trees required further hand thinning. The trees showed little injury.

**Killing Poison Ivy.** (L. Southwick.) In August 1943, ammonium sulfamate was applied to poison ivy growing under apple trees. With a small power sprayer, approximately 3 gallons of solution were required per large tree to wet thoroughly the rank ivy growth. Concentrations of  $\frac{1}{2}$ ,  $\frac{3}{4}$ , and 1 pound of the chemical per gallon of water were apparently effective in killing the ivy foliage. Recovery as of June 1944 is spotty, and the small amount of ivy that is growing does not have a normal or healthy appearance. However, on the basis of previous tests, a partial recovery in the season following applications indicates that additional treatment is required; if omitted, the ivy is very likely to continue to grow and increase. In general, the results seem to indicate that probably  $\frac{3}{4}$  to 1 pound of ammonium sulfamate per gallon of water is an effective spray for poison ivy control.

The lower limbs of an apple tree were sprayed to observe the extent of injury. The sprayed foliage was killed inside of 24 hours and the killing later extended somewhat back from the sprayed portions. In other words, the chemical was evidently transported a short distance to unsprayed foliage and killed it. Although this does not seem to be a serious feature, care should be taken to keep the spray off the foliage of all fruit trees.

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## DEPARTMENT OF POULTRY HUSBANDRY

R. T. Parkhurst in Charge

**Broodiness in Poultry.** (F. A. Hays.) Attempts to establish a line of Rhode Island Reds that do not transmit the broody instinct have been greatly handicapped by the limited life span of the birds, by deferred broodiness, and by restricted numbers. The generation hatched in 1942 included 106 females sired by two 24-months-old males mated to hens with no record of broody manifestation. There was no evidence of broodiness in any of these daughters. The generation hatched in 1943 was also from aged parents and consisted of 81 daughters, which are now in their first laying year. They will be tested for deferred broodiness, which is probably the most important obstacle to overcome.

**Effectiveness of Selective Breeding to Reduce Mortality.** (Regional Poultry Research Laboratory, and Departments of Veterinary Science and Poultry Husbandry, Massachusetts Agricultural Experiment Station cooperating.) Records have been completed to the age of 18 months on all males and females hatched in 1942; to March 1, 1944 (about 11 months) on the 1943 generation; and to May 1 on the 1944 generation. Mortality rates for the first 6 months were decidedly lower in the low mortality line. Adult mortality from 6 to 18 months was significantly lower for females in the low line. Results for males were distorted by excessive cannibalism. The recessive lethal gene reported last year in the high mortality line appeared again in 1944 but to a lesser extent than in 1943.

Data for the 1943 generation from 6 to 11 months of age indicate that the incidence of diseases of the paralysis complex was not high in any of the lines. Cannibalism was the major cause of death; but no reason is evident why cannibalism should have been so much more prevalent in the high mortality line when birds of all lines were housed together. The data indicate further that selective



breeding has increased longevity as measured by the age at death of birds in the high and low lines.

There is some evidence to indicate that inbreeding will uncover weaknesses that produce excessive mortality.

A preliminary report on the character of the lethal mutation that appeared in the high line in 1943 was published in the *American Naturalist* in 1944.

**Genetic Laws Governing the Inheritance of High Fecundity in Domestic Fowl.** (F. A. Hays and Ruby Sanborn.) Factors governing the inheritance of high intensity are less well understood than are the factors concerned in the inheritance of other characters affecting egg production. Recent studies have shown that intensity is the most variable character in our flock and that it bears an important relationship both to egg size and to number of eggs. The data indicate that intensity of laying responds to selective breeding.

Winter pause is governed both by genetic factors and by environmental conditions. Studies are being carried on to bring out the importance of inheritance in controlling this character.

Recent studies have been directed toward the possibility that other inherited factors, aside from the five well-recognized characters, may affect egg production.

**A Study of Fertility Cycles in Males.** (F. A. Hays.) The phase of this project concerned with the use of sex hormones in regulating male fertility was begun in the spring of 1944. Preliminary results indicate that sex hormones may be of value in stimulating spermatogenesis in males that are 36 months old, but not in younger males.

**Physiological Relationships Between Molting Behavior and Fecundity Characters.** (F. A. Hays and Ruby Sanborn.) Extensive data on molting behavior and results of selective breeding are available for six generations. One line was selectively bred for a short period of laying after the onset of annual wing molt. A second line was developed for the ability to lay for a long period after the onset of annual wing molt. The second line were superior producers.

**A Genetic Analysis of Rhode Island Red Color.** (F. A. Hays.) Two lines have been developed: the first, genetically late in sexual maturity; and the second, genetically early maturing. Differences in feather color between the two lines are being studied. Colorimeter studies of feather pigments indicate a multiple factor inheritance of feather color in Rhode Island Reds.

**Miscellaneous Genetic Studies.** (F. A. Hays.) The sex-linked gene E for early sexual maturity has been eliminated from some crosses between Barred Plymouth Rocks and Rhode Island Reds, to study the effect of autosomal gene E' alone on age at sexual maturity. A line lacking both genes E and E' has been established. Appropriate crosses have been made for these tests.

Progress has been made in separating the sexes of Rhode Island Red chicks on the basis of down color. A gold bar line that shows sex-dimorphism at hatching has been developed.

Ultra-violet light has not been effective to date in producing mutations in chickens.

**The Value of Starfish Meal in the Poultry Starting Ration.** (Raymond T. Parkhurst, in cooperation with Roy E. Morse and Francis P. Griffiths of the Department of Food Technology.) The commercially produced meal made by dehydrating starfish (*Asterias Forbesi*) can be satisfactorily used as a source of protein and minerals in chick starting rations.

**Corn Distillers' By-Products in Chick Rations.** (Raymond T. Parkhurst and Leonard E. Parkinson of the Nutrition Laboratory, in cooperation with Walter L. Nelson and Frances E. Volz, Schenley Research Institute, Lawrenceburg, Indiana.) Corn distillers' dried grains without solubles were used satisfactorily in the starting and broiler rations to replace ground oats and dried solubles, but not wheat bran and dried distillers' solubles. The feed efficiency was somewhat improved by the inclusion of corn distillers' dried grains without solubles; the difference in pigmentation and feathering was negligible.

Corn distillers' grains with solubles satisfactorily replaced dried skimmilk and wheat bran, wheat middlings, or ground oats in a starting ration for chicks, with an improvement in the feed efficiency.

Soybean oil meal with corn distillers' grains successfully replaced all the dried skimmilk, fish meal, and meat scraps in the starting ration.

**Corn Distillers' By-Products in Laying and Breeding Rations.** (Raymond T. Parkhurst in cooperation with Carl R. Fellers, Department of Food Technology, and John W. Kuzmeski of the Feed Control Service.) Three corn distillers' dried by-products — grains without solubles, grains with solubles, and solubles — were used as replacements in complete all-mash rations for Rhode Island Red and crossbred pullets in laying cages.

When the distillers' by-products replaced dried skimmilk pound for pound in rations containing either meat scraps or fish meal, there were no appreciable differences in egg production, feed consumption, feed efficiency, weight of egg, yolk color, open egg quality, egg shell texture, body weight changes, or mortality. Hatchability was not satisfactory when grains without solubles replaced dried skimmilk. Corn distillers' dried grains without solubles, when used to the extent of 10 percent in laying rations containing meat scraps, gave good egg production.

Corn distillers' dried grains with solubles, when used at the 10 percent level, with soybean oil meal and without animal protein supplements, proved satisfactory for egg production. When grains with solubles, up to 20 percent of the ration, were used to replace all the soybean oil meal and part of the ground barley and wheat bran in rations containing meat scraps but no dried skimmilk, egg production was satisfactory and the hatchability of fertile eggs was very good. With fish meal as a supplement, 5 percent of grains with solubles satisfactorily replaced either 2.5 percent of dried skimmilk or 3.5 percent of dried solubles.

Corn distillers' dried solubles, with soybean oil meal and without any animal protein supplements, proved of outstanding value for egg production. With fish meal as a supplement, satisfactory egg production and hatchability resulted when 3.5 percent dried solubles replaced 2.5 percent of dried skimmilk.

Corn distillers' by-products had no adverse effect on the weight of eggs, body weight gains, or egg quality as measured by shell breaking strength, height of albumen, and yolk color.

Fish meal proved a more valuable supplement for distillers' by-products than meat scraps for feed efficiency and hatchability. In combination with fish meal, equally good egg production and hatchability results were obtained when dried skimmilk was replaced by distillers' dried solubles, distillers' grains with solubles, or fermentation solubles.

**Supplement for Distillers' Dried By-Products in Breeding Rations.** (Raymond T. Parkhurst in cooperation with John W. Kuzmeski of the Feed Control Service.) In further studies with distillers' dried by-products, more evidence was obtained that fish meal contains one or more hatchability factors not yet identified and other than riboflavin, pantothenic acid, choline, or biotin. Hatchability was best in the groups of birds getting a ration containing 20 percent

of milo-rye dried distillers' grains with solubles and flame-dried redfish meal, and poor in the groups of birds getting a similar ration without either meat scraps or fish meal.

Hatchability was excellent when birds were fed a ration containing milo-rye dried distillers' solubles at the 5 percent level, supplemented either with liver meal or with a combination of dried skim milk, fish meal, and meat scraps at the same crude protein level. Poor hatchability was obtained from groups getting similar rations with no added animal protein, with or without dried brewer's yeast and/or choline chloride.

**Methods of Feeding---Hatchability Studies.** (J. H. Vondell.) Two pens of 70 Red females mated to 7 males were fed a complete all-mash ration; two pens of 70 Red females mated as above were hopper fed mash, whole corn, wheat, and oats; and 1000 eggs from each of the four pens were incubated in five lots. The complete mash ration gave 76.0 percent fertility and 88.7 percent hatchability of fertile eggs; the hopper feeding resulted in 78.3 percent fertility and 88.5 percent hatchability of fertile eggs.

**Poultry Housing Projects, Winter of 1943-44.** A. (C. I. Gunness and W. C. Sanctuary.) A non-insulated, two-thirds span, 20 x 20 pen was equipped with a special ventilating device consisting of a horizontal flue at the front of the house at floor level. From this a fan blew the air through a narrow slit over most of the litter and towards the rear of the pen. The intake to the flue drew in the warmer air from the point high in the pen, mixed with controllable amounts of fresh air admitted from out of doors. The net change of air was kept at a low point to maintain as high a room temperature as possible—within 2 to 5 degrees of similar adjoining insulated pens. The moisture content of the litter was about 13 percent higher than in the adjoining insulated pens ventilated by baffled window openings. There was but little condensation on the ceiling. There was little or no indication of discomfort to birds from the forced air current near the floor, in contrast to last year's test when a more rapid air flow was produced by use of a larger fan.

B. (W. C. Sanctuary.) Two 20 x 20 insulated pens were ventilated only with window openings equipped with baffle boards which deflected sharply downward all wind-driven incoming air. Provision for outgoing air was made by an ample space above the baffle device. Tests showed that the baffle increased the recirculation of warm air naturally set up in a typical laying pen by the body heat of the birds. Negatively the device prevented any direct drafts from blowing into the pen at a high level, which would neutralize or completely counteract the natural heat circulation, a result often observed in pens ventilated with the usual window openings. The hens' actions indicated no discomfort from the downward deflected air.

One of these pens had also a complete rearrangement of equipment. The nests were on the back wall. Indications are that heat from birds laying in the nests tended to increase the normal circulation over the litter from the front to the rear of the laying pens. Elevated pits  $2\frac{1}{2}$  feet forward of the nests and 30 inches from the floor prevented any floor drafts from the cellar sash openings in the rear wall near the floor (open in the summer) from striking the birds on their elevated perches. These pits held one month's droppings and proved easier to clean than floor pits, as well as obviating any danger of rotting out permanent floors or rear walls. The pits were equipped with an alighting perch which made it unnecessary to teach the pullets to go to roost. The water founts and non-wasting hoppers were elevated from the floor leaving practically the entire floor



space free for birds and for the uninterrupted circulation of air. This arrangement materially increased the hens' working floor space, which should increase the laying house capacity substantially, an important objective.

The birds laid a few more eggs in the pen with the new housing arrangement. The moisture content of the litter was somewhat less even though this was an end pen, which made it more difficult to keep dry because of tracked in snow and moisture. The caking of the litter in the two pens showed a greater difference, being worse and more extensive in the pen equipped with the conventional dropping boards and floor hoppers, while in the specially arranged pen it was confined largely to the area around the water fount.

C. (J. H. Vondell and W. C. Sanctuary.) Birds in four pens in the new insulated house were fed two kinds of rations. Two pens received a ration consisting of three parts of mash and one part of grain. The other two pens were cafeteria fed mash and grain ad lib., the birds in this case eating less than 50 percent mash. It has been claimed that the feeding of all-mash or high-mash rations had no material effect on moisture content of litter. These tests proved the contrary to be true. On December 24 in the two pens where the birds ate a high percentage of mash, the average moisture content of litter was 48 percent (very wet); in the two pens with a low percentage of mash consumption, the moisture content of litter was 33 percent. The feeding method was then reversed, and by December 31 the moisture content of litter had changed with the feeding method, the new high-mash pen having 49 percent moisture and the new low-mash pen going down to 42 percent from the former 48 percent level.

Other pens, not in the test, where an all-mash ration was compared with a low-mash ration showed similar differences.

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## DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

**Poultry Disease Control Service.** (H. Van Roekel, K. L. Bullis, O. S. Flint, and M. K. Clarke.)

1. *Pullorum Disease Eradication.* A keen interest in pullorum disease testing has been noted during the past two seasons, particularly during the 1943-44 season when the volume of testing increased over the previous season by 142,459 tests. The trend in establishing and maintaining pullorum-free flocks continues to be highly favorable.

In view of war conditions, every possible effort has been made to meet this exceedingly great demand for testing. However, the strain on the laboratory facilities and personnel should not be of a permanent nature if the quality of the service is to be maintained at a high level.

Detailed reports of the two testing seasons are published in bulletins of the Control Series.

2. *Diagnostic Service.* This section of the report is based on the calendar year of 1943. A total of 3,674 specimens was received in 709 consignments, of which 377 were delivered in person. There was a sharp increase in the number of specimens and an all-time high figure for the laboratory was reached. This was perhaps due to the larger number of birds reared with less help and by inexperienced persons. The specimens were classified as follows: 3,228 chickens, 332 turkeys, 28 pheasants, 22 pigeons, 21 ducks, 11 rabbits, 9 each of foxes and swine, 4 canine feces, 3 bovine semen, 2 each of bovine organs, bovine feces, and guinea pigs, and 1 raccoon.



Coccidiosis (135), infectious bronchitis (73), tumors (67), pullorum disease (43), and so-called unknown disease (41) were the disease disturbances encountered most frequently. The tumors were classified on the basis of gross examination as follows: 44 lymphocytoma, 6 leukemia, 3 each of carcinoma and myelocytoma, 2 each of embryonal nephroma, hematoma, and unidentified; and 1 each of hepatoma, hemangioma, melanoma, myxoma, and thymoma. Avian tuberculosis was identified once and fowl typhoid twice. Fowl cholera was identified on 16 additional premises, bringing the total number of premises known to be infected during the past 10 years to 71. Fowl cholera was found in ducks and turkeys as well as chickens. A serious outbreak of avian tuberculosis was identified in pheasants on one farm. Subsequent investigation by representatives of the Bureau of Animal Industry, United States Department of Agriculture, revealed that over 90 percent of the old birds and about 6 percent of the young birds were infected.

A disease disturbance caused by coal tar, creosote, and anthracene oil was recognized in chicks. Chicks brooded from the time they are a day old in quarters recently treated with one of these products, may manifest trouble at about three weeks of age. The disturbance is similar to that observed in chicks fed rations containing excessive salt. Affected chicks may show retarded growth, ragged feathering, somnolence, difficult breathing, coughing, and moist tracheal rattling. Postmortem examination may reveal extensive edema of the subcutaneous tissues and the lungs, and an increase in fluid in the pericardial and body cavities. Cardiac enlargement, splenic atrophy, and sometimes pneumonia are observed. The kidneys and liver may vary in size but are usually swollen.

The 332 turkeys were received in 63 consignments. The diseases encountered most frequently were coccidiosis and enterohepatitis. Paratyphoid infection was encountered less frequently than formerly; whereas the number of cases of pullorum disease was the same as for the previous year. Disturbance due to a lack of vitamin A was recognized in birds of nearly marketable age. Two cases of fowl cholera were noted. Sinusitis, which had not come to our attention earlier, was identified in three cases. A serious outbreak of disease in one flock was identified as hexamitiasis.

3. *Flock Mortality Studies.* In a continuation of the work on the flock maintained at the College for genetic studies, 317 morbid and dead birds have been examined from the group hatched in the spring of 1942. There were 169 females and 148 males. The number of males examined was much higher than for any previous year, partly, no doubt, because of a greater effort to get all specimens to the laboratory.

The female population was sacrificed in January 1944 because of an acute outbreak of pullorum disease. This made only a minor difference in the records because only a small percentage of the population remained at the time of the outbreak, since the birds had completed their first laying year and had been disposed of in accordance with the usual practice. The origin of the pullorum infection was not established. The major portion of the infection was in a house containing birds, all of which were over 18 months of age. Repeated retesting of the remainder of the flock has failed to reveal additional infected birds.

Cannibalism was the primary cause of death of 54 females. Losses from cannibalism were particularly severe from March to August or during the period when the birds were over one year of age. Reproductive disorders (30), tumors and leukemia (26), fowl paralysis (14), and kidney disorders (11) were other important disease conditions noted. The incidence of fowl paralysis, which follows an erratic pattern in the flock, was less than one-third of that in the population of

the previous year. The tumorous conditions were identified on the basis of gross examination as leiomyoma (9), lymphocytoma (8), myelocytoma (2), and miscellaneous (7).

4. *Salmonella Types Isolated.* Fifteen strains of paratyphoid organisms were recovered from consignments received from 11 poultry flocks and one herd each of swine and foxes. Eight *S. typhi-murium* strains were isolated from three chickens (including one mature bird), one fox, one turkey poult, and three adult pigeons. *S. tennessee*, *S. anatum*, *S. worthington*, and *S. bredeney* were isolated in one instance for each, the first two from poult and the last two from chicks. *S. bareilly* was recovered from specimens from the same premises on two different dates, one from a poult and the other from a chick. One of the *S. typhi-murium* strains was isolated from a poult from these premises also. *S. cholera-suis* var. *Kunzendorf* was recovered from a swine herd.

We are greatly indebted to Dr. Philip Edwards, Department of Animal Pathology, University of Kentucky, Lexington, Kentucky, who identified these strains as to type.

5. *Fowl Cholera in Ducks.* During the past year, a severe epornitic of fowl cholera occurred on a large duck farm in Massachusetts. No definite information could be obtained as to the origin of the outbreak, but during May 1943, the infection caused a sudden and heavy mortality in the flock especially among the ducklings. In some instances evidence of infection could be observed in ducks four to six weeks of age, but in many cases the heavy losses did not occur until the ducklings were eight to ten weeks of age. Losses varied among different hatches. The characteristic symptoms and lesions described for duck cholera were observed.

A special request was made to the laboratory for assistance in controlling this disease. Since autogenous bacterin has been recommended for the control of duck cholera, this laboratory agreed to produce and supply sufficient bacterin to inoculate the young ducklings that the owner planned to raise for the balance of the season. A total of approximately 25,500 ducklings hatched from June 25th to September 18th was inoculated. A total of 88,200 cc. of bacterin was supplied. Some lots of ducks received as many as four inoculations (2 cc. each) at approximately two-week intervals. No uninoculated controls were maintained. The mortality rate ranged from 3.3 to 79 percent for the different lots. As the season progressed the mortality rate declined, but with some fluctuation.

The owner was inclined to believe that the use of bacterin caused a reduction in losses. However, a critical analysis of the data did not justify such a conclusion. It was evident that in some lots the use of the bacterin failed to control losses, even though the first inoculation was made prior to signs of the infection.

Sulfathiazole was also tested as to its effectiveness in controlling active outbreaks of duck cholera. The limited data obtained suggested that this drug had little if any influence on the mortality of the disease. However, further experimentation is necessary to arrive at a definite conclusion.

The purpose of resorting to biologic therapy and chemotherapy was to aid the owner to finish his rearing season with as little loss as possible. The main objective was the elimination of the infection from the premises through a complete depopulation and sanitary program. At this writing, no evidence of cholera has been observed in young stock reared this season. However, sufficient time has not elapsed to permit a statement as to whether or not the infection has been completely eliminated.

6. *Infectious Bronchitis.* During the past year and a half the infectious bronchitis control work was extended to the majority of counties in the State. The Extension Service and the Division of Livestock Disease Control have continued to cooperate in this program. A total of 153 flocks was selected for the control project.

The production of virus material and the inoculation work were carried on in a manner similar to that of the previous year. The post-inoculation reactions were very favorable for the most part. In some instances no "takes" were obtained because the flock was immune as the result of previous exposure. Mild reactions which could not always be explained satisfactorily were obtained in some flocks. Severe reactions were observed when the flock was apparently in poor physical condition.

In November 1943 there were approximately 200,000 laying birds in the flocks which were considered protected against infectious bronchitis virus. The results of the past year further substantiate that birds immunized against infectious bronchitis during their pre-ovulation stage are able to resist natural infection to the degree that egg production is not interrupted. This crude but simple procedure for protecting commercial laying and breeding flocks against infectious bronchitis has met with great demand by the flock owners in the State. As the result of this interest, the work has been placed on a control service basis in order to execute the program more effectively. However, further research is necessary to improve methods of diagnosis of the disease, production of virus, and methods of inoculation of the virus.

7. *Farm Department Brucellosis Control and Eradication.* The laboratory tested 369 bovine and 27 porcine blood samples by the standard tube agglutination method during the past year.

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## WALTHAM FIELD STATION

Waltham, Massachusetts

Ray M. Koon in Charge

The members of the research staff of the Waltham Field Station are assigned to this branch by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Refer to reports of these departments for results of investigations conducted at this Station.

**Soil Testing Service.** Commercial vegetable growers, mushroom growers, florists, nurserymen, and vendors of loam brought in 2850 soil samples for testing and consultation.

There was a marked increase in the number of samples from home gardeners due to the activity of the Victory Garden movement. From 3835 individuals 5626 samples of soil were submitted, making a total of 8476 samples tested.

**Testing Pressure Canner Gages.** Aware that many pressure canners would be put into operation for food preservation, the Field Station offered to test the gages and safety valves. Of the 232 sent in only 85 were accurate. The remainder registered from 1 to 7 pounds too low or too high. Many of the safety valves were stuck and failed to blow off at pressures dangerous to the operator.

**Field Day.** Because of the shortage of gasoline and tires, the lack of farm machinery and other equipment for demonstration purposes, the annual meeting, which would have been the twenty-fifth, was not held.



## PUBLICATIONS

## Bulletins

- 398 Annual Report for the Fiscal Year Ending November 30, 1942, 64 pp. January 1943.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

- 399 Peach Growing in Massachusetts. By John S. Bailey. 16 pp. illus. January 1943.

Peaches have a limited adaptability to Massachusetts climatic conditions, and this deals with management practices essential for their successful production.

- 400 Breeding Snapdragons for Resistance to Rust. By Harold E. White. 16 pp. illus. February 1943.

Rust is a disease destructive to the ornamental value and seed productive capacity of snapdragons, and the results of attempts to produce resistant strains for greenhouse and garden use are here presented.

- 401 Plant Characters of Cherry Varieties. By A. P. French. 23 pp. illus. February 1943.

Considerable economic loss has resulted from planting cherry trees untrue to name. As an aid in the elimination of such a hazard, this bulletin directs attention to the characteristics by which nursery trees may be identified and records the important differences between the principal varieties.

- 402 Weather in Cranberry Culture. By Henry J. Franklin, H. F. Bergman, and Neil E. Stevens. 91 pp. illus. April 1943.

Weather plays an important rôle in cranberry culture. This is an attempt to interpret the influence of various weather conditions on this crop.

- 403 Descriptions of Apple Varieties. By J. K. Shaw. 187 pp. illus. April 1943.

The identification of fruit varieties before trees leave the nursery is important if disappointments in the orchard are to be avoided. These pictures and descriptions, including most of the apples now in common cultivation in America, are intended to help others to recognize these varieties and to serve as a record for future generations.

- 404 Home Dehydration of Vegetables. By S. Gilbert Davis, William B. Esseen, Jr., and Francis P. Griffiths. 24 pp. illus. April, 1943.

The emphasis on food conservation as a result of the war has aroused special interest in methods of preservation. The possibilities of home dehydration as a practical method are here presented.

- 405 Agricultural Finance in Massachusetts. By Sargent Russell and A. H. Lindsey. 39 pp. June 1943.

The general impression that Massachusetts farmers are heavily burdened with debt has a tendency to increase the cost of farm loans. This study was undertaken to determine the facts regarding this financial situation.

- 406 Feeding Urea to Dairy Cows. By J. G. Archibald. 166 pp. July 1943.

The scarcity of protein concentrates has created an interest in the use of urea as a partial substitute in dairy rations. Tests of its desirability are reported here.

- 407 Questions and Answers Concerning Pullorum Disease. By H. Van Roekel. 32 pp. illus. July 1943.



The purpose of this bulletin is to make available for the Massachusetts poultry industry information which will aid the poultrymen to improve their methods of establishing and maintaining pullorum disease-free flocks.

- 408 Home Refrigeration and Food Preservation. By John E. W. McConnell, William B. Esselen, Jr., and Carl R. Fellers. 19 pp. illus. July 1943.

With proper use an efficient household refrigerator reduces danger of the development of food poisoning organisms to a minimum and effectively preserves the quality and vitamin content of foods.

- 409 The Grape Plume Moth, with Notes on Other Pests of Grapes in Massachusetts. By W. D. Whitcomb, Wm. E. Tomlinson, Jr., and E. F. Guba. 20 pp. illus. October 1943.

Part I reports for the first time the complete life history and control by dormant spraying of the Grape Plume Moth, an obnoxious pest in home vineyards in eastern Massachusetts. Part II describes briefly other insects and diseases likely to attack grapes and includes a complete spraying and dusting schedule for their control.

- 410 Propagation of the High-Bush Blueberry by Softwood Cuttings. By W. L. Doran and J. S. Bailey. 8 pp. illus. November 1943.

Blueberries are difficult to propagate because the cuttings root so slowly. These experiments were planned to find a method for decreasing the percentage of failures encountered at present.

- 411 Variability in Egg Weight in Rhode Island Reds. By F. A. Hays. 16 pp. illus. January 1944.

Market grades of eggs are based largely on weight, and it is important, therefore, for the breeder to know how much variability in egg weight may be considered normal and how much is due to genetic factors.

- 412 The Cabbage Maggot. By W. D. Whitcomb. 28 pp. illus. February 1944.

The Cabbage Maggot is a destructive pest of cruciferous plants in Massachusetts, and successive crops can seldom be grown successfully without providing protection against it. The most satisfactory treatments to use on certain types of plants and for different degrees of infestation are recommended.

- 413 The Identification of Plum Varieties from Non-Bearing Trees. By Lawrence Southwick and A. P. French. 51 pp. illus. March 1944.

The identification of varieties before fruit trees leave the nursery is important if disappointments in the orchard are to be avoided. This bulletin considers the characteristics by which nursery plum trees may be identified and records descriptions and photographs of 57 varieties.

- 414 Bacteria and Rural Water Supplies. By James E. Fuller. 20 pp. June 1944.

This is an attempt to give intelligent direction to what constitutes sanitation in rural water supplies.

- 415 Sunflowers as a Crop. By Karol J. Kucinski and Walter S. Eisenmenger. 8 pp. illus. June 1944.

Sunflowers as a farm crop deserve consideration in Massachusetts because of their merits as a feed for poultry and other livestock in this area where adequate and satisfactory supplies of feed are of foremost concern.

- 416 Relation of Intensity to Egg Weight and Egg Production. By F. A. Hays. 12 pp. June 1944.

Intensity is one of the most important inherited characters affecting egg production. This study brings out important relationships between intensity, egg weight, and egg production in an improved flock.

**Control Bulletins**

- 116 Twenty-third Annual Report of Pullorum Disease Eradication in Massachusetts. By the Poultry Disease Control Laboratory. 11 pp. July 1943.
- 117 Inspection of Commercial Feedstuffs. By the Feed Control Staff. 16 pp. September 1943.
- 118 Inspection of Commercial Fertilizers and Agricultural Lime Products. By Fertilizer Control Service Staff. 26 pp. September 1943.
- 119 Seed Inspection. By F. A. McLaughlin. 63 pp. November 1943.

**Meteorological Bulletins**

- 649-660, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By C. I. Gunness. 4 pp. each.

**Reports of Investigations in Journals****NUMBERED CONTRIBUTIONS**

- 436 Relation of Weather Conditions to Onion Blast. By Linus H. Jones. *Plant Physiol.* 19 (1):139-147. 1944.
- 443 The Diagnosis of Avian Neoplasia. By K. L. Bullis and Carl Olson, Jr. *Amer. Jour. Vet. Res.* 4 (31):382-387. October 1943.
- 446 New Stabilizing Materials for Ice Cream. By A. M. Shipley, M. J. Mack and J. H. Frandsen. *Canad. Dairy and Ice Cream Jour.*, vol. 22, no. 7. July 1943.
- 447 An Explanation of the Increased Efficiency of Gelatin in Ice Cream Mix when Initially Aged at 68°F. By W. S. Mueller. *Jour. Dairy Sci.* 26 (2):189-204. February 1943.
- 450 Egg Production versus Reproduction in Rhode Island Reds. By F. A. Hays. *Poultry Sci.* 22 (2):118-122. March 1943.
- 451 Alkaline Phosphatase and Egg Formation. By Marie S. Gutowska, Raymond T. Parkhurst, E. M. Parrott, and R. M. Verburg. *Poultry Sci.* 22 (3):195-204. May 1943.
- 455 The Composition and Palatability of Some Common Grasses. By J. G. Archibald, E. Bennett, and W. S. Ritchie. *Jour. Agr. Res.* 66 (9):341-347. May 1943.
- 458 Soluble Chlorine in Feeding Stuffs. By John W. Kuzmeski. *Assoc. Off. Agr. Chem. Jour.* 26 (1):87-90. 1942.
- 460 Carbohydrates of the Ebenezer Onion. By Emmett Bennett. *Food Res.* 8 (4):273-274. 1943.
- 461 The Influence of Variety, Size, and Degree of Ripeness upon the Ascorbic Acid Content of Peaches. By G. M. Schroder, G. H. Satterfield and Arthur D. Holmes. *Jour. Nutr.* 25 (5):503-509. May 1943.
- 462 Magnesium Deficiency in Massachusetts Apple Orchards. By Lawrence Southwick. *Amer. Soc. Hort. Sci. Proc.* 42:85-94. 1943.
- 463 Comparative Results with Sprays and Dusts in Controlling the Preharvest Drop of Apples. By Lawrence Southwick. *Amer. Soc. Hort. Sci. Proc.* 42:199-202. 1943.
- 464 Inheritance of Mottled Earlobes and Stubs in Rhode Island Reds. By F. A. Hays. *Amer. Nat.* 77:471-475. September-October 1943.
- 465 Measuring Performance of Progeny of Rams in a Small Flock. By M. E. Ensminger, R. W. Phillips, R. G. Schott, and C. H. Parsons. *Jour. Anim. Sci.* 2 (2):157. May 1943.
- 466 Hay Mulches in Apple Orchards. By J. K. Shaw. *Amer. Soc. Hort. Sci. Proc.* 42:30-32. 1943.

- 467 Experiments with Lima Beans. By William H. Lachman and Grant B. Snyder. *Amer. Soc. Hort. Sci. Proc.* 42:554-556. 1943.
- 468 They're Tops! By Emmett Bennett. *Jour. Home Econ.* 35 (5):288. May 1943.
- 469 Some Acidic Properties of Alkali Lignin. By Emmett Bennett. *Soil Sci.* 55 (6):427-431. June 1943.
- 470 The Effect of Cocoa upon the Utilization of the Calcium and Phosphorus of Milk. By W. S. Mueller and Marilyn R. Cooney. *Jour. Dairy Sci.* 26 (10):951-958. October 1943.
- 471 The Inheritance of an Agglutinin of the Chicken Erythrocyte. By Carl Olson, Jr. *Jour. Immunol.* 47 (2):149-154. August 1943.
- 472 Relationships of Natural Vegetation to the Water-Holding Capacity of the Soils of New England. By Walter S. Colvin and Walter S. Eisenmenger. *Soil Sci.* 55 (6):433-446. June 1943.
- 473 Crab Meal in Poultry Rations. I. Nutritive Properties. By Joseph A. Lubitz, Carl R. Fellers, and Raymond T. Parkhurst. *Poultry Sci.* 22 (4):307-313. July 1943.
- 474 Identification of Certain Red and Purple Raspberry Varieties by Means of Primocanes. By O. C. Roberts and A. S. Colby. *Amer. Soc. Hort. Sci. Proc.* 42:457-462. 1943.
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- FM-13 Returns from Pasture Treatment. By Charles R. Creek. 19 pp. April 1943.
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- Pest Control in the Home Garden. By A. I. Bourne and O. C. Boyd. Mass. State Col., Ext. Leaflet 171 (revised).
- The Fungicide and Insecticide Situation. By A. I. Bourne and O. C. Boyd. Mass. State Col., Ext. Spec. Mimeographed Cir.
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- Pest Control Calendar for Potatoes (revised). By A. I. Bourne and O. C. Boyd.
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MASSACHUSETTS  
AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 428

OCTOBER, 1945

Annual Report

For the Fiscal Year Ending June 30, 1945

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The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

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# **ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1944-45**

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## **DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT**

**A. H. Lindsey in Charge**

**The Effect of Public Regulation of Milk Marketing Upon the Organization of the Milksheds of Massachusetts Markets.** (Alfred A. Brown, Elaine P. Miller, and Judith E. Rosenthal.) The collection, editing and tabulation of a series of price receipts and sales data for the ten years since milk control began is nearing completion. Efforts have been concentrated on the milksheds and markets in the principal secondary areas of Springfield, Worcester, Lowell-Lawrence, Fall River, and New Bedford.

In addition to contributing some light on the manner in which prices finally develop under public control, the study will provide a reasonably authentic series of data upon which the industry can build in coming years. Study has indicated the shortcomings and inadequacy of existing price records, and current work is directed towards overcoming that deficiency. Although this phase of the work may appear secondary to the major premise, it is important in a program of public pricing. And since milk control appears to be a permanent part of dairy marketing in Massachusetts the contribution of an accurate historical price series appears to be well worth while.

**Transportation Requirements of Rural Communities in Massachusetts.** (Alfred A. Brown and Elaine P. Miller.) The second part of this study was completed during the past year. The results of the analysis of milk trucking operations have been put to use in the principal dairy areas of the State. Daily truck mileage involved in moving milk from farms to plants had been 23,897. Following the study and conference with the industry this was reduced to 21,458 with a net saving of slightly over 10 percent.

**A Study of Farm Real Estate Taxation, Methods of Taxation Reform, and the Effect of Such Measures on Farm Income.** (Elaine P. Miller, Alfred A. Brown, and Judith E. Rosenthal.) The transcription of tax and assessment records on farms in the "Sampling Study" and on a selected group of dairy farms has been under way. About two-thirds of the records are in. Preliminary analyses have been made only for dairy farms and an extremely wide range exists between towns in valuations of livestock; cows from \$40 to \$125, chickens from 50 cents to \$1.25, and horses from \$25 to \$200.

Other indications are that real estate will show much variation in assessment; that there will be little uniformity between real estate taxes paid and personal property taxes paid; that there will be little if any relationship in 1944 between size of farm (in acres) and amount of tax paid.

**Development of Statistical Data as Controls to Livestock Production Program.** (Alfred A. Brown, Elaine P. Miller, and Judith E. Rosenthal.) All three phases of field work in connection with this study have received much attention. The checking of maps, identification of farm locations, and collection of pertinent data on them have been completed for five counties. Classification of data has been advanced to the point necessary to permit selection of dairy farms.



For the dairy farms picked up in the identification detail, data on livestock numbers have also been secured from AAA milk subsidy records.

In the third sample under consideration, that used by the New England Crop Reporting Service, livestock numbers have been transcribed and tabulated.

Incomplete coverage of the major phase of the work precludes testing of the several samples. Comparison between the major sample and census population on a county or regional (three Valley counties) basis indicates an inaccurate selection. The random sample, selected on a square-inch-grid basis, is over-weighted with small herds.

**Loan Performance on Low Income Farms in Massachusetts.** (C. R. Creek.) Standard rehabilitation loans which were made by the Farm Security Administration from 1936 through 1943 on 89 cash-crop farms in the three Connecticut Valley counties of western Massachusetts had been repaid in full by 66 farmers by June 1945. Of the remaining cases, 13 were classified as active borrowers who had received loans within the past two years, 5 were collection cases on old loans, and 5 had defaulted on their loans after making some repayments. Payments on these loans were made in large amounts from the sale of onions, potatoes and tobacco. Three years of good yields and high prices for crops enabled these farmers to pay off current and delinquent loans.

Standard loans which were made on 95 livestock and livestock-crop farms during this period were repaid by 53 borrowers by June 1945. Of the remaining cases, 25 were classed as active borrowers, 11 were collection cases, and 6 had defaulted on their loans after making some repayments. These loans were generally set up on a longer schedule of payments than the crop loans and payments were usually made each month from sales of poultry and dairy products. Payments from sales of crops were made by 74 borrowers to repay loans from 1936 to 1945. Sales of livestock and livestock products were the source of repayments on 21 farms. Auctions of livestock and equipment were necessary to close 14 loans, and income from work in industry was used to complete payments on 10 loans. On 62 percent of the farms, loans were repaid from crops; on 18 percent, from livestock enterprises; and on 20 percent, from sales of capital assets and industrial employment.

One or more standard rehabilitation loans had been made between 1936 and 1943 to 184 borrowers and by June 1945 loans were repaid in full on 119 farms or 65 percent; 38 loans or 21 percent were classified as active; and 27 loans or 14 percent were collection and defaulted cases. New loans were made in 1945 to seven borrowers, but not all of the active borrowers received supplementary loans in 1945.

**Clearing and Improving Land on Massachusetts Farms.** (C. R. Creek and J. F. Hauck.) Practically every farm in Massachusetts contains a few acres of once productive land that has reverted to timber, brush, shrubs, or weeds. Also many farms are divided into small fields of one to five acres by stone walls which were built many decades in the past. Other fields contain boulders and stones which prohibit the use of modern labor-saving machinery.

Within the past five years heavy machinery such as bulldozers, gas shovels, brush-breaker plows, and bog harrows have been used to clear land of trees, stumps, brush, and boulders, remove stone walls, dig drainage ditches, construct erosion controls, and remove old apple and peach trees from orchards. Land has been cleared in present farming units for pasture, poultry range, orchards, cranberry bogs, vegetable crops, potatoes, and field crops. In a few cases the acreage which has been cleared and improved was greatly in excess of the original cleared acreage, but in most cases from 5 to 20 acres of land have been cleared to increase the size of the original farm.

Costs of clearing land with heavy machinery varied greatly depending upon the type and density of timber, stump, or brush cover, the type of soil, the size and adaptability of equipment used, the skill of the operator, and the purpose for which the land was cleared. Records on costs and methods show that stump-land has been cleared ready to plow for as little as \$65 per acre and as much as \$180. Brush and trees have been cleared for \$75 to \$140 per acre and boulders removed for \$60 to \$150 per acre. Stone walls were removed by burying or hauling away for \$6 and \$9 per rod depending upon size of the wall and methods used. Apple trees were removed from orchards for 25 to 45 cents per tree and usually the value of cordwood cut more than paid for the cost of removal and cutting. Some drainage work has been done on individual farms but much of this land improvement work will be done after Soil Conservation Districts are formed.

Some examples have been noted of land clearing which could not be justified on the economic returns from the land. Where a good type of soil is available in the farm unit for the purpose desired, clearing with modern machinery may be profitable in a period of high prices for farm products. Larger acreages can be brought into production more rapidly by clearing with machinery to take advantage of these higher prices.

**Organization and Management of Poultry Farms in Massachusetts.** (C. R. Creek.) Poultry farming was less profitable in 1944 than in 1943 according to the summary of Poultry Account Records, chiefly because of lower prices received for eggs and higher prices paid for feed. For the records summarized, net farm income averaged \$2350 per farm in 1944, \$3660 per farm in 1943, and \$2388 in 1942. Labor income per hen was \$2.13, \$4.20, and \$2.85 for an average flock of 863,768, and 691 laying hens per farm. Egg production was 210 eggs per hen in 1944, 196 in 1943, and 206 in 1942 and the average price for all eggs sold was 47, 55, and 42 cents per dozen.

In 1944 the net farm income was \$4604 per farm for the one-third highest income farms, which were chiefly breeder type farms, in contrast to \$302 per farm for the lowest one-third, which were wholesale egg type farms. The size of laying flock was 1280 and 480 hens on these two groups of farms, while total size of the farm business was 690 and 250 productive man work units. Egg production was 216 and 189 eggs per hen and the average price received was 49.7 and 43.5 cents per dozen. The cost of feed per dozen eggs produced was 23.3 cents on the profitable farms and 29.7 cents on the low income farms. The margin of price received for eggs over cost of feed was 26.4 and 13.8 cents per dozen. It required 83 eggs at prices received to purchase 100 pounds of grain on the higher income farms and 97 eggs on the lower income group. A greater quantity of grain was fed per laying hen on the low income farms than on the more profitable farms and a higher price was paid per hundredweight. All of these factors of size, rate of production, prices received, feeding efficiency, and type of business were jointly responsible for the wide variation in returns from the farm business in these two groups.

A comparison of 15 identical poultry farm accounts for 1942, 1943, and 1944 showed that size of flock increased 16 percent from 819 to 953 hens. Egg production dropped 5 percent in 1943 to 200 eggs per hen but the price received was 56 cents per dozen which was 30 percent greater than in 1942. Feed cost per dozen eggs was 30 percent greater in the latter two years also, while the price received for eggs in 1944 was only 11 percent more than in 1942. The egg-feed ratio was most favorable in 1943 when 5.5 dozens of eggs were required to purchase 100 pounds of mash and scratch grain. The cost of hired labor on these farms increased 56 percent in these three years from \$60 to \$94 per month. Total labor cost, which included the value of the operator's time and family labor as

well as hired labor, increased only 38 percent while the efficiency of labor increased 18 percent as measured by man work units per man. The proportion of eggs sold as hatching eggs was greatest in 1943 at 38 percent of all sales, compared to 26 percent in the other years. Retail egg sales remained uniform in quantity during these years but the proportion of wholesale eggs was lower in 1943. Net farm income was \$2890, \$4260, and \$2940 per farm for these three years. Labor income was \$2370, \$3715, and \$2355, and there was an increase in investment from 1942 to 1944 of \$1300 per farm. Farm income was \$3.53, \$4.74, and \$3.08 per hen on these farms.

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## DEPARTMENT OF AGRONOMY

Walter S. Eisenmenger in Charge

### **Tobacco Projects.** (Walter S. Eisenmenger and Karol J. Kucinski.)

*Brown Root Rot of Tobacco.* The object of this project was to determine the effect of the preceding crop on the yield and quality of tobacco. The various preceding crops were planted at three different times. All of the first seeding and some of the second matured; but none of the late seeding. All were plowed under during the following spring when they had been quite completely dehydrated by alternate freezing and thawing. The tobacco crop following the more mature of the preceding crops was not so good as that following the less mature plants. Mature plants contain more lignin and compounds not readily decomposed by microorganisms. Of the many crops grown preceding tobacco, tobacco, sunflowers, Jerusalem artichokes, and potatoes stand out most favorably; while sorghum, sudan grass, and corn are frequently exceedingly unfavorable to the tobacco crop. It is worthy of mention that the more favorable crops to precede tobacco are members of the Compositae and Solanaceae families, while all of the unfavorable ones belong to the Gramineae and Leguminosae families.

*Black Root Rot of Tobacco.* (C. V. Knightlinger.) In work to improve Havana Seed tobacco for use in the Connecticut Valley, new strains are being produced to effect improvements over Havana Seed 211 and other strains produced thus far. Some of the new strains are capable of producing high yields of tobacco of good type and quality in soils infested with the organism that causes black root rot as well as in soils relatively free from this organism. According to experimental results obtained from small plot tests, some of the new strains seem to possess improvements over Havana Seed 211 in type, quality, and habits of growth. The strains are being tested commercially, and some of them seem to be very promising.

*Brown Root Rot of Tobacco.* (C. V. Knightlinger.) Brown root rot ordinarily develops on tobacco that is grown immediately following certain other farm crops. Frequently, however, the disease fails to develop under these conditions in the Connecticut Valley. The cause of the disease and the reasons why at times it fails to develop under seemingly favorable conditions are not well known. The purpose of this project is threefold: first, to ascertain the effect on the development of brown root rot of tobacco of the rate at which fertilizer is applied to the preceding crop; second, to ascertain whether brown root rot will develop on tobacco grown continuously when less than the ordinary amounts of fertilizer are used; and third, to study the effects that conditions of low fertility may have on the root ailments of certain farm crops other than tobacco.

Work on the project is still in the preliminary stage of preparing the soil for fuller study of these objectives.



**Disinfection of Tobacco Seedbeds.** (C. V. Kightlinger.) Fall and spring steaming, chloropicrin, fall treatment with double strength formaldehyde, and spring treatments with single and double concentrations of formaldehyde were tested as soil disinfectants in tobacco seedbeds in 1944. The results were similar to those obtained in previous years.

Fall and spring steaming and chloropicrin were highly effective in the control of weeds. Fall and spring treatments with double strength formaldehyde were somewhat more effective than the spring treatment with single strength formaldehyde, although none of the formaldehyde treatments gave satisfactory control of weeds.

No damping-off or bedrot occurred in the seedbeds during the season; therefore, the comparative effectiveness of the different treatments in preventing seedbed diseases of tobacco could not be determined.

**The Absorption by Food Plants of Chemical Elements Important in Human Nutrition.** (Walter S. Eisenmenger and Karol J. Kucinski.) Both the type of ion and the evolutionary development of the plant seem to have a part in regulating the intake of the various ions into the plant. The elements proportionately more abundant in sea water than in land waters seem to be more easily introduced into the plant. The more highly developed flowering plants seem to take up elements applied to the soil less than do the less developed types. Under similar conditions less calcium is taken up than potassium, sodium, and magnesium when each is added separately at the rate of 250 p.p.m. Chlorides, bromides, and iodides can be increased by larger percentages in plants than can phosphorus and sulfur when the two last-mentioned elements are applied to soil as phosphates and sulfates. The halides are more abundant in sea water than in land waters.

**The Intake by Plants of Elements Applied to the Soil in Pairs Compared to the Intake of the Same Elements Applied Singly.** (Walter S. Eisenmenger and Karol J. Kucinski.) When 250 p.p.m. of calcium, magnesium, potassium, or sodium were added singly to plots, the intake of each into plants was increased. When two of these cations were added at the same rate to a single plot, the intake of each was less than when either of the two was added singly.

Preliminary experiments with seedlings of soybeans in water solution indicate that the higher the copper content of the growing medium, the lower is the calcium content of the aerial portion of the plant. These results may not necessarily hold true under field conditions. In field tests 75 pounds of copper sulfate was applied per acre. Plants grown on these plots will be analyzed to determine the effect of copper on the intake of calcium within the plant.

**Magnesium Requirement of Plants.** (Walter S. Eisenmenger and Karol J. Kucinski.) During the past growing season, 1944, no heavy rains fell from the time of planting to the time of harvest. This was conducive to conservation of magnesium of the soil. Only a few species of plants showed the effects of slight deficiency of the element in the soil. This was apparently true throughout the State as no reports were available from extension and research men, or from individuals who usually bring in samples of plants grown on soils deficient in magnesium.

The Ranunculaceae, Malvaceae, Ulmaceae, Geraniaceae, and Cruciferae showed the deficiency only to a slight degree. No plants usually ascribed to the higher orders gave evidence of the slightest deficiency of magnesium.

Not all plants show the usual symptom of chlorosis. Among these plants are some of the purslanes and a few of the roses — *Portulaca oleracea*, *Rubus villosis*, *Potentilla canadensis*; and the common strawberry shows only an exceedingly



limited degree of chlorosis when magnesium is not sufficient for normal growth. The development from apocarp to syncarp marks an apparent diminution in need for the magnesium ion.

**Long-Time Field Fertility Tests.** (Walter S. Eisenmenger and Karol J. Kucinski.) Fifty-five to sixty years ago a series of soil test plots was established to study the effects on the soil and crops of a long-time fertilizer program. Various types of crops have been grown on these plots with the original plan of fertilization being followed each year. For the last three years the crop has been hay. Plots which receive a complete fertilizer and lime are outstandingly superior to all other plots. Check plots which have not received any kind of fertilizer since the inauguration of the tests show complete crop failure, with "haircap" moss coming in during the second season after seeding. In preliminary tests, rabbits fed grass grown on the limed plots showed growth curves superior to those of rabbits fed grass grown on the unlimed plots.



Young Sunflower Plants  
The large leaves shade the ground preventing the growth of weeds.

**Sunflowers and their Possibilities.** (Karol J. Kucinski and Walter S. Eisenmenger.) Results of tests for several years show that sunflowers will grow abundantly in this region, producing good yields on any land which will grow corn. Sunflowers are hardy to light frost, and can be planted when it is safe to plant field corn. The plants are much more resistant to frost when they first come up than at the four or six leaf stage. Field trials have shown that the best spacing is one seed every 18 inches in 36-inch rows for the tall varieties like the Mammoth Russian. For shorter varieties like the Mennonite or Sunrise, 12 inches between plants and 36 inches between rows is recommended. Last year's trials indicate that the shorter-growing Canadian varieties (Sunrise and Mennonite), although yielding about 500 pounds less seed per acre, were superior to tall-growing varieties like Mammoth Russian in ability to withstand wind storms. The labor involved in taking care of sunflowers during the growing season is very little, since the plant starts to grow rapidly and soon shades the ground completely, killing any weeds that may survive the one or two early

hoeings. Because of its thick vegetative cover the sunflower plant serves admirably in ridding infested areas of obnoxious weeds.

**Soil Conservation Research Projects.** (Karol J. Kucinski and Walter S. Eisenmenger.)

*Physical and Chemical Properties of Wind-Blown Soils.* For several years laboratory tests and field observations have been made to determine why certain soils are subject to wind erosion while others are not. A wind tunnel has been used to supplement field observations.

Because of the unusually small amount of snow cover last winter, 1943-44, dust storms were very severe in the Connecticut River Valley. It was observed at several localities that wind erosion would start as soon as six hours after rainfall. In such cases the soil that was moved by the wind was the very thin top layer and usually contained less than 1 percent moisture, while the immediate sublayer contained 10 to 20 percent moisture. The application of such compounds as urea and lithium carbonate to soils greatly decreased their wind erodibility.

*Use of Snow Fencing in Controlling Wind Erosion.* One of the problems of Connecticut Valley farmers is the protection of soils and their crops from wind damage. The northwesterly winds which occur during early spring result in considerable losses to soil, seed, fertilizer, and young crops. Farmers have often noticed that certain local areas or spots are much more subject to blowing than the remainder of the field. This may arise from various conditions or a combination of conditions such as the location of buildings, slope of the land, direction of rows, difference in soil texture or drainage, etc. These "blowouts" usually appear sporadically in different years and under certain weather conditions. With the present emphasis on farm production, the farmer does not want to abandon these areas, yet the damage to his seed and young crops such as onions and asparagus may be considerable. To control these local "blowout" spots temporarily until the crop has established itself, some form of windbreak may be used. Trials are being made at the station to see whether so-called highway snow fencing will prove satisfactory for the purpose.

Results from these preliminary studies show that the anchorage of such fencing need not be so complicated as when it is used for prevention of snow drifting of highways. Old iron pipes or wooden stakes 4½ to 5 feet long driven 18 inches into the ground and spaced a rod apart held up the 4-foot-high lath fencing throughout the entire season. If the fencing is placed on the windward edge of the "blowout" at right angles to the prevailing winds and the crop rows are placed parallel to the fencing, very little loss of area or inconvenience in operation will be experienced. Generally one fence row will be sufficient to control "blowouts" of the size commonly found in this section. The cost of snow fencing is about 15 cents a running foot at present, but would be considerably less under normal conditions. This seemingly high initial cost should be prorated with respect to the longevity of the fence.

*Erosion Problems Arising from Changes in Land Use.* The increase of potato growing in certain localities in Massachusetts has resulted in soil erosion problems. Some operators are already experiencing a decrease in potato yield and have called on the Soil Conservation Service for aid in formulating plans for the protection of their fields. Laboratory tests show that there is an abnormal decrease of organic matter on some of these soils. It was found on several farms in western Massachusetts that the organic matter decrease in six years ranged from 14 to 31 percent with most of the decrease taking place in the first 2 or 3 years. It is deemed advisable, therefore, to encourage potato growers to practice soil conservation methods such as winter cover-cropping, terracing, and contour farming of their hillsides.

**Potato Seed Treatments.** (C. V. Kightlinger and H. M. Yegian.) Experimental work begun in 1943 was continued in 1944, to ascertain further the comparative tolerance of varieties of potatoes grown commonly in Massachusetts to commonly used disinfecting seed treatments, and also the effectiveness of these seed treatments in controlling rhizoctoniose and scab. The varieties grown were Chippewa, Katahdin, Sebago, Earlane, Irish Cobbler, and Green Mountain. The seed treatments used were mercuric chloride plus acid, yellow oxide of mercury, Semesan Bel, Sanoseed, Wettable Spergon, Thiosan, and Fermate. At the time of treatment, the seed potatoes were sprouted only slightly.

The inorganic treatments caused little injury to Irish Cobbler and Green Mountain tubers; moderate injury to Katahdin, Sebago, and Earlane; and rather severe injury to Chippewa. These treatments caused reduction in stands of potatoes in the field, ranging from slight in the case of Irish Cobbler and Green Mountain to rather heavy in the case of Katahdin, Earlane, and Sebago and heavy in case of Chippewa.

The organic seed treatments had no noticeable injurious effects on the tubers of any of the varieties before planting; but Semesan Bel, Sanoseed, and Thiosan had some detrimental effects on the stands of the Katahdin and Earlane varieties and worse effect on the stand of the Chippewa, in the field.

None of the seed treatments seemed to increase the vigor of the plants. Careful examination of growing plants and later inspection of mature tubers after digging showed no consistent difference in the amounts of rhizoctoniose that developed from the use of any of the seed, treated or untreated. No scab developed by which to judge the effectiveness of the seed treatments as control measures for this disease.

On the basis of experimental results obtained from two years of testing, it seems that disinfecting seed treatments are of doubtful value as control measures for rhizoctoniose of potatoes at least. Rather heavy reduction in yields of potatoes of the newer varieties occurred, which it seems reasonable to attribute to the poor stands caused by the detrimental effects of some of the treatments on the seed tubers. On the basis of these facts, it seems doubtful whether disinfecting seed treatments are advisable for potatoes, especially for the newer varieties used in these tests.

**Potato Variety Trials.** (Karol J. Kucinski, Ralph W. Donaldson, Walter S. Eisenmenger.) Because of the favorable growing season last year, all of the potato varieties tested did well, with yields per acre ranging from 510 bushels for Sebago to 347 bushels for Russet Rural.

Based on yields of marketable size, the ranking of potato varieties in the Experiment Station plots during the season of 1944 was Sebago, Pontiac, Sequoia, Chippewa, Green Mountain, Warba, Mohawk, Katahdin, Houma, Irish Cobbler, and Russet Rural.

**Corn Improvement Program.** (Hrant M. Yegian.) Fifty-five single crosses were made in the early-maturing group, involving all possible combinations of eleven inbred strains. Thirty-six double crosses were also made from the more promising of the previous year's ninety-one single crosses. Ninety-two varieties, mostly hybrids, were tested for their general adaptability and yield. The results were published in mimeographed form with the cooperation of the Extension Service, and are available upon request.

**Onion Breeding.** (Hrant M. Yegian.) Lots of 100 seeds from crosses between *Allium fistulosum* and *A. cepa* were soaked at room temperature in 0.1 percent colchicine solution from  $\frac{1}{2}$  to 120 hours to induce tetraploids. The majority of the seeds soaked from 3 to 5 days had thickened cotyledons and primary roots



at the seedling stage indicating chromosomal aberrations, but the leaves and the subsequent adventitious roots produced were normal. No tetraploids were observed in mature plants.

Over 50 percent of the bulbs from the first generation inbred strains having 2, 3, 4, 5, or 6 seed stalks per plants produced 3 or 4 seed stalks. The size of the bulbs, storage temperature, cultural practices, and weather conditions, as well as the genetic constitution of the strains, affect the keeping quality of bulbs, seed stalk development, and amount of seed produced.

Preliminary evidence tends to show that applications of borax at the rate of 30 to 50 pounds per acre did not prevent pink-root or fusarium bulb rot of growing onions, or increase the amount of seed produced by mother bulbs. However, it seems that borax may possibly have some subsequent beneficial effect on the keeping quality of stored onions. At least in these trials the sets grown on borax-treated plots produced onions that kept better in storage, had brighter, more uniformly colored skin, and a more presentable appearance than did the onions grown from sets produced on untreated plots.

Seed from an improved strain was introduced last year to be tested by a commercial onion grower. The test is still in progress. However, the strain appears to be promising.

**Experiments at Amherst with Hay and Pasture Seeding Mixtures.** (W. G. Colby.) One of the principal objectives of these trials was to study the performance of different grass species and strains when seeded in combination with ladino clover alone and with ladino clover and alfalfa. It was hoped that strains of grass could be found which would be more satisfactory when grown with either one or both of these legumes than those now in general use; but even if superior strains were not found, it was thought that much valuable information might be secured which would be helpful in the development of a successful grass breeding program. Significant progress has been made in both directions. In these trials the following strains of orchard grass, meadow fescue, and perennial rye grass gave outstanding performance: orchard grass—S 26, S 37, and Finnish late hay; meadow fescue—Svalof Early and Otofte; perennial rye grass—O.A.C. No. 1 (now called Peron). A description of the experimental layout for this work has been given in a previous report (Mass. Agr. Expt. Sta. Bul. 388:14-15, 1942).

Breeding objectives have been formulated and breeding material has been isolated for further improving one already promising strain of orchard grass. It is probable that similar work will be attempted with certain strains of smooth brome grass.

As these different seeding mixtures have been observed from year to year (the plots are in their fifth harvest season), it has become increasingly evident that the performance of each mixture as well as each strain is influenced by many different factors. Among the most important of these are soil fertility relationships, including fertilizer practices; the nature of the original seeding mixture; the cultural management, including grazing management practices; and finally, the weather. In predicting the performance of a given hay or pasture strain of grass with ladino clover or alfalfa, the influence and relative importance of each of the above factors should be borne in mind.

**Field Brome Grass (*Bromus arvensis*) for Poultry Ranges.** (W. G. Colby.) Certain poultrymen have use for a grass which, when seeded in late summer or early fall, can be ranged the following spring on through to midsummer. Then, for the purposes of sanitation, they prefer to plow the land and reseed it for range the next season. Preliminary trials indicate that field brome grass can be successfully used in this way.



In early September 1944, two acres were seeded with field brome grass by a poultryman in Feeding Hills, Massachusetts. Results thus far in 1945 have been most promising. By spring this grass had made a dense matted growth which has since stood up well under heavy ranging conditions. A cover has been maintained even around range shelters and feeding stations. The herbage appears to be reasonably palatable.

The present season has been abnormally wet and this may account for some of the favorable results thus far. If this grass performs satisfactorily in a year with normal rainfall, poultrymen will have available another valuable grass for use on some of their ranges.

Field brome grass (*Bromus arvensis*) is a winter annual which must not be confused with smooth brome grass (*Bromus inermis*) which is a true perennial. Field brome grass has been used to a limited extent in Europe as a forage grass, but, as yet, its use in this country has been confined only to experimental trials. Seed was first secured by the Agronomy department in 1937 from a commercial seedsman in Germany and in 1938 from the Royal Danish Agricultural Society. Seed for these field trials on poultry ranges has been supplied by the Nursery Division of the U.S.D.A. Soil Conservation Service. Seed is not yet available commercially.

**Breeding Work with Orchard Grass.** (W. G. Colby.) Notwithstanding such desirable characteristics as tolerance to heat and drought, wide range of soil adaptability, good yielding ability, and resistance to lodging, orchard grass has never been popular for either hay or pasture. One reason has been its habit of early maturity. When used in hay mixtures, orchard grass matures from one to two weeks before any of the other common grasses or legumes in the mixture. If it is cut after maturity, it makes coarse, poor-quality hay. Its early maturity also makes it a poor pasture grass. Unless it is grazed promptly in the spring, it will form seed heads and become quite unpalatable.

Strains have been developed which mature from a week to ten days later than commercial strains and several have done well in the seeding mixture trials. However, most of these late maturing strains, including S 26, S 37, and S 143, are very susceptible to winter injury in the seedling stage and frequently suffer serious winter injury in established stands during severe winters.

One strain—Finnish late hay—has been found which is as hardy as commercial orchard grass, even in the seedling stage, yet matures from a week to ten days later. Seed of this strain was obtained in 1938 from a commercial seedsman in Finland. It has shown up well in both hay and pasture mixtures. It combines well with alfalfa and does reasonably well with ladino clover; at least it is much superior to all early-maturing hay strains of orchard grass. For the past two years seed has been increased so that small quantities are available for trial.

In order to further improve the performance of Finnish late hay orchard grass, a space-planted nursery was set out in 1944 using this seed. Late-maturing, winter-hardy plants, with desirable morphological characteristics were selected in 1945. These have been selfed and their progeny will be tested in 1946. It is expected to develop a new strain following the "strain building" procedure.

**Trials with New Oat Varieties.** (W. G. Colby.) For several years yield trials with new disease-resistant oat varieties have been carried on in cooperation with the U.S.D.A. Division of Cereal Crops. The following varieties have given good grain yields and have shown high resistance to leaf rust: Vicland, Tama, and Clinton. While oats are relatively unimportant as a grain crop in Massachusetts, they are grown quite widely for forage. Varieties resistant to leaf rust are, therefore, more valuable for Massachusetts conditions.

## DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

**A Study of the Mineral Elements of Cow's Milk.** (J. G. Archibald and C. H. Parsons.) The work with cobalt is still in progress. Extreme difficulties have been encountered in developing a method sufficiently refined to determine the very minute traces of this element present naturally in milk. All of the time devoted to the project this year has been spent in trying out different methods none of which have so far yielded reproducible results.

**Investigation of the Merits of Legume and Grass Silage for Massachusetts Agriculture.** (J. G. Archibald and C. H. Parsons.) A good grade of silage has been produced this past year by mixing corn meal with various grasses at the rate of 150 pounds of meal per ton of grass. The silage kept very well, had a pleasing, mildly acid odor, and has been very palatable to cows. Considerable differences have been noted in the suitability of different grasses for ensilage. Reed's canary grass made only a fair quality of silage; bluegrass alone has not been at all satisfactory; but bluegrass mixed with other grasses has made good silage. In general, silage from a mixture of grasses or of grasses and legumes has been more satisfactory than silage made from single species.

Two technical articles based on this project have been accepted for publication during the past year. One, entitled "Seepage losses from a silo," appeared in the *Journal of Dairy Science*, Vol. 28, No. 4, April, 1945, pages 321-324. The other, entitled, "Studies in the chemistry of grass silage," will appear in the *Journal of Agricultural Research* presumably within the next three or four months. Conclusions of the first-mentioned article were that seepage losses in silage are not as serious as losses from other causes, and with good management can be reduced to a very insignificant figure. The most important conclusion in the second paper was that variations in silage quality due to the kind of crop ensiled were more significant than those due to the action of the preservative.

In addition to this work on the formal project, some time has been devoted to checking by observation and analysis the results obtained by a group of farmers who ensiled surplus potatoes furnished to them by the War Food Administration. In general a fair to good grade of silage was obtained, although a few failures have been noted.

Analyses of four lots of potato silage, one ensiled with alfalfa, two with oat hay, and one with sweet corn fodder, show that these silages were higher in protein, carbohydrate, and minerals than corn silage; lower in crude fat and fiber; and much lower in carotene. This last is what would be expected, for potato tubers do not contain carotene; and what little was found came from the relatively small amount of roughage mixed with the potatoes when they were chopped.

The quality of the silages made by mixing alfalfa or sweet corn fodder with the potatoes was excellent; when oat hay was used, the quality was only fair the rather high pH (4.9) indicating an unsatisfactory and insufficient fermentation. More serious than any failure to obtain good silage, however, has been the damage to cutter knives by stones mixed in with the potatoes during harvesting.

**The Effect of Feeding Synthetic Thyroprotein to Milking Cows.** (J. G. Archibald.) For a period of approximately seven months (April to November, 1944) this project was conducted in the Holstein herd of the Medfield State Hospital. Ten cows fed the hormone continuously for a period of twenty-one weeks, starting about midway of their lactation periods, showed a definite response in milk yield. In general this response took the form not of marked or sudden increase in milk yield, but of greater persistency in milk flow than was to be expected

from the production records of these cows in the first part of their lactations. At the end of the fortieth week of lactation, after twenty-one weeks of hormone feeding, average weekly production was 227 pounds per cow in comparison with an expected weekly production, based on previous performance, of 162 pounds per cow.

Four cows fed the hormone in alternate four-week periods for twenty-four weeks showed a definite response in the first two alternate periods, but it was unlike that of cows fed the hormone continuously in that it took the form of sharp increases in yield while the hormone was fed, followed by just as sharp decreases when it was discontinued. By the time the third and last alternate period of hormone feeding had been reached this sharp upward trend was no longer manifest and actual production dropped nearly to the level of expected production.

Of four cows fed the hormone in alternate two-week periods for twelve weeks, only one showed a marked response in milk yield.

Increases in milk production were usually accompanied by some loss in body weight, especially in the group that received this hormone continuously. These losses varied considerably in individual cows; over a period of five months they averaged approximately 50 pounds per cow in the continuous group, 30 pounds per cow in the 4-week group, and 20 pounds per cow in the 2-week group. No adjustment of the rations of these cows was made, but more recent work in the State College herd indicates that such losses can be made good by increasing the grain allowance in proportion to the increased milk yield.

There were no significant changes in the general condition, appearance, or behavior of these cows, neither was the composition of the milk significantly affected. There was some apparent disturbance of the reproductive function in the continuous group, these cows requiring on the average twice as many services for conception as they had required the previous year.

Because of labor conditions at the Medfield State Hospital, work on this project was transferred to the State College herd in the autumn of 1944. In the work in progress here, emphasis is being placed on the effect of the hormone on milk composition. Nineteen cows (seven Ayrshires, six Holsteins, and six Jerseys) were included in the trials conducted during the past winter. All that can be said at this time is that there have been rather marked differences in response to the hormone by the different breeds and also by different individuals within a breed. The project is being conducted in cooperation with Cerophyl Laboratories, Inc., of Kansas City, Missouri, which is furnishing the necessary thyroprotein.

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## DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

**Bacteriological Studies of Rural Water Supplies.** (James E. Fuller.) This is a study of the growth and behavior of coliform bacteria at incubating temperatures up to 46° C., in the effort to evaluate the many atypical cultures encountered in testing rural water supplies. The cultures employed in the study were obtained from water samples sent to the laboratory for routine testing. Only typical *Escherichia coli* of sewage type was able to produce gas from lactose at 46° C. Most of the cultures studied proved, on this basis, to be soil-type coliform bacteria of questionable sanitary significance. Good results were obtained from the use of the methyl-red test at 44° C. This procedure seemed able to separate typical *E. coli* (positive at 44° C.) from atypical coliform cultures (positive at 37° C., but negative at 44° C.).



**Relation of Chloramine-Resistant Bacteria to Milk Supplies.** (James E. Fuller.) Previously published results (J. New England Water Works Assoc., 58: 89-100, 1944) showed a substantial increase in the number of positive presumptive tests (gas production in lactose broth) obtained in routine testing of the water after the chlorine-ammonia treatment was begun. These tests, however, could not be confirmed; that is, they were false presumptive tests. During the past year studies have been made to determine the cause of the false presumptive tests. Results follow:

1. Numbers of Gram-negative bacteria have been isolated that resemble coliform bacteria except for their failure to confirm, that is, to produce gas in lactose broth within 48 hours of incubation at 37° C. 2. By passing the cultures through successive tubes of lactose broth, the ability to produce gas within 48 hours was built up in a number of them. 3. By combining the cultures with one another, or with certain Gram-positive aerobic spore-forming cultures also isolated from the water, it was possible to obtain positive presumptive tests.

The conclusion was that the false presumptive tests obtained from the water supply are caused by coliform bacteria whose fermentative capacity had been so weakened by environment that they were unable alone to produce gas from lactose, but could do it when combined with other cultures. This study has been accepted for publication in the Journal of the New England Water Works Association for September, 1945.

The last phase of the study, now under way, is to investigate the possible effect of these bacteria on milk supplies. Some work has been done to determine their rate of multiplication in milk at several temperatures ranging from room temperature to that of normal refrigeration in an electric refrigerator. The production of acid and curd in milk under these conditions is also being investigated. Work on this phase of the problem has not progressed sufficiently to warrant any statement of results at this time.

**Study of Septic Tank Efficiency.** (James E. Fuller.) A preliminary statement has been made (Mass. Agr. Expt. Sta. Bul. 417, 1944, p. 17) explaining the origin of this project as a cooperative study with the State Board of Health Division of Engineering. After the Department of Bacteriology took over the project, a part of the tank installation was rebuilt, with the cooperation of the Department of Engineering of the Experiment Station, to eliminate certain faulty features of the original design.

It has not been possible to operate the project continuously, partly because the dormitory that supplies sewage to the tank has been occupied by pre-aviation cadets on a "here today and gone tomorrow" basis, and partly because the installation is not housed, with the result that deep snow and very cold weather necessitated suspension of operation in mid-winter of 1944-45. However, some results have been obtained.

The main object of the project was to study the effect of retention period on the efficiency of the tank in digesting the sewage. The tank has three compartments which receive sewage at rates that provide retention periods of 24 hours, 12 hours, and 8 hours respectively. The tank was put into operation in late August, 1944. Scum formed rapidly in the 12-hour and 8-hour compartments, and the outlets from both were plugged up solidly by early December with scum about 8 inches thick. The scum in the 24-hour compartment formed gradually and more normally and was about 2 inches thick when operation was suspended.

Bacteriological studies of the effluent showed that the coliform bacteria recovered at the beginning of operation were mostly typical *Escherichia coli*, while after about six weeks the type changed to *Citrobacter* which is a member of the coliform group but not so indicative of immediate fecal pollution as *E. coli*.



This indicated that conditions within the tanks changed so as to favor growth of the *Citrobacter* rather than *E. coli*. The bacteriological results were about the same for all three compartments, as to both numbers and types of bacteria recovered.

Laboratory Service, July 1, 1944, to June 30, 1945. (James E. Fuller.)

Milk samples, bacteria counts .....	170
Ice cream samples, bacteria counts .....	79
Water samples, bacteriological tests .....	148
Total .....	397

## DEPARTMENT OF BOTANY

A Vincent Osmun in Charge

Diseases of Trees in Massachusetts. (M. A. McKenzie and A. Vincent Osmun.)

*The Dutch Elm Disease Problem.* As of July 1, 1945, the Dutch elm disease caused by the fungus *Ceratostomella ulmi* (Schwarz) Buisman, has been isolated from 54 trees in 19 municipalities in Massachusetts as follows:

Berkshire County	1941	1942	1943	1944	1945
Alford .....	1			2	
Egremont .....		3	2	3	
Great Barrington .....		1	1	6	2
Hancock .....					1
Lenox .....					2
Mount Washington .....				1	
Pittsfield .....				3	
Richmond .....					5
Sandisfield .....				1	
Sheffield .....		1		3	
Stockbridge .....				2	
West Stockbridge .....			1		
Williamstown .....					1
Hampden County					
Holyoke .....				2	
Longmeadow .....				1	
Southwick .....				2	
Springfield .....				2	
Westfield .....		1			
West Springfield .....				2	

In both Berkshire and Hampden Counties the spread of the disease is favored by the relatively unbroken continuity of elm population in valleys; and the prospect appears that in Hampden County, because of additional complications, the disease if unchecked may become more prevalent than in Berkshire County.

Certain conditions favor control, but not exclusion, of the disease in the eastern part of the State. In general, elms are more restricted there to plantings of ornamental and street trees. Such trees are likely to be better cared for by either private or public agencies. Also, in metropolitan areas, as contrasted with rural areas, elm in woodpiles favorable for breeding of bark beetles which carry the disease fungus, is not so common, and usually there is less movement of elm logs which might be infested with the carrier beetles. Additional factors affecting disease distribution throughout the State are yet to be evaluated.

In all parts of the State where diseased trees are found, surveys are made in the immediate vicinity and recommendations furnished to public and private agencies concerning desirable control measures. Although recommendations are made for particular conditions, they may be summarized as follows:

1. Keep elms as healthy as possible.
2. Spray elms to control elm leaf beetle and other insects.
3. In particular, if elms are cut, remove and burn the bark immediately. The bark beetles which carry the disease fungus breed in the bark of freshly cut elm.
4. Avoid piling elm wood in the open unless it is peeled. Don't transport elm wood with bark attached. Piled elm wood is more dangerous than standing dead trees.

Other methods of disease control are being explored, and, in cooperation with the Department of Entomology, means for control of carrier insects are under investigation.

*Other Tree Problems.* Fifty-four diseases of thirty species of trees including eight diseases of elm were identified from approximately 350 specimens and inquiries received during the year. The *Cephalosporium* wilt of elm was reported from two additional municipalities in which the disease has been found in Massachusetts. *Verticillium* sp. was isolated from several species of wood plants.

On September 14, 1944, a hurricane struck southeastern Massachusetts with devastating force. Along the coast the water did not invade and undermine property to the extent of the hurricane of September, 1938, but not until long after the excitement of the storm had passed, and in some instances not until the spring of 1945, was the complete effect of salt and wind on trees fully realized. In Barnstable, Plymouth, and Bristol counties thousands of trees were uprooted or shattered. Transportation and communication facilities were suspended or impaired for days or weeks while conditions were righted amid complications of shortages in labor and materials. A visit to the "graveyard" of almost any tree department is a revealing picture of trees lost. As for trees which withstood the storm, in the course of clearing operations they were sometimes left in hopelessly mutilated condition. Inadequate repair of injured trees always paves the way for future failure of damaged limbs. In limbs and crotches a hurricane rends the weak spots and creates additional ones. Viciously enough these in turn often become casualties of lesser storms. Events of recent years serve well to emphasize the need for better tree care and the detection of minor tree defects which may be corrected at limited expense. Neglect of current needed work is an expensive and indeed a deceiving false economy.

In many communities of Massachusetts on April 23 and 24, 1945, early morning frosts injured foliage of trees on which leaves had developed in response to warm spring weather. Damage varied from extensive on fruit trees to limited on some shade and ornamental trees.

Leaf diseases have been unusually prevalent on shade trees during June. The regularity with which rains occurred favored the development and dissemination of fungi involved. In some instances leaves damaged by frost, wind, and fungus infection had already fallen by July first, to a conspicuous extent.

During a severe electrical storm in Amherst on June 15, 1945, the following trees on the State College campus were struck: a large elm south of the tennis court near the cold storage plant, a large elm on Stockbridge Road west of French Hall, a sycamore northwest of Butterfield House, a linden east of North

College, and an ash west of Clark Hall. Damage varied from slight scorching of trunk to debarking of individual limbs and complete demolition of the ash.

In the early summer of 1945, two street trees, in each case located near catch basins into which water drains from near-by hillside streets, showed damage suggestive of chloride injury. During the winter the streets involved are well coated with salt to eliminate ice. Because of heavy snow and spring rains the water levels of basins were rather high this spring. Local conditions suggested that salt, which ordinarily might not be available to near-by trees, had reached their roots as a result of an unusual combination of circumstances.

#### **Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment. (W. L. Doran.)**

Work on the propagation of high-bush blueberry by softwood cuttings was continued in cooperation with John S. Bailey, and a second paper was published on the subject.\* Cuttings rooted better if taken not later than 2 to 3 weeks before the first berries ripened. Their rooting was most improved and hastened by B-(indole-3)propionic acid, less by potassium indolebutyrate, and least by indolebutyric acid. Powder-dip treatments did not give so good results with blueberry cuttings as did solution-immersion treatments, but there were good results with Spergon-Hormodin No. 2.

Especial attention was given to the effects of combinations of certain fungicides with root-inducing substances, usually in the proportion of 1:1 by volume, for the treatment of cuttings.

In work with Lawrence Southwick it was found that length of life of unrooted softwood cuttings of McIntosh apple was consistently increased by Spergon-Hormodin No. 2 or No. 3, but was not prolonged by Hormodin No. 1 or No. 2 used alone. The life of such cuttings was also lengthened if, after solution-immersion treatment with indolebutyric acid, they were treated with Spergon alone. Mid-June cuttings of McIntosh rooted 33 percent after treatment with naphthaleneacetic acid followed by Spergon-Hormodin No. 2, not at all if treated with naphthaleneacetic acid alone.

Treatments of cuttings of rose with Spergon tended to retard rooting and subsequent growth, but Arasan or Fermate similarly applied gave good results. Thus, in a typical instance, rose cuttings rooted in the following percentages: check, 58; Hormodin No. 1, 77; Arasan-Hormodin No. 2, 93; indolebutyric acid 2 mg./gm. Fermate, 95. For rose cuttings, sand is to be preferred to sand-peat. It was found that the best type of rose cutting has 2 buds, one (upper) leaf with 3 leaflets or, if a 5-leaflet leaf, with the tip leaflet removed.

White pine cuttings, rooting not at all without treatment and relatively poorly with Hormodin No. 3 alone, rooted 64 percent after treatment with Fermate-Hormodin No. 3.

Cuttings of arbor-vitae rooted much better after treatment with indolebutyric acid 8 mg./gm. Arasan, Fermate, or Spergon than after similar treatment with indolebutyric acid in a carrier of talc. Indolebutyric acid 8 mg./gm. Fermate also gave excellent results with *Juniperus chinensis* L. var. *Sargentii* Henry. Cuttings of southern balsam fir rooted better if, after solution-immersion treatment with indolebutyric acid, they were given a powder-dip in Arasan or Spergon.

Probably because the root-inducing substance was too much diluted by the fungicide (there did not appear to be chemical injury), rooting of cuttings of the following species was more improved by treatment with Hormodin No. 3 than by treatments with mixtures of it and the fungicides named below: Colorado

\*Doran, W. L. and Bailey, J. S. Propagating the high-bush blueberry by softwood cuttings. American Nurseryman 81:7:10. 1945. (Mass. Sta. Contrib. 554.)



fir and Sawara cypress with Arasan or Fermate; *Abies nephrolepis* Maxim. with Arasan, Fermate, or Spergon.

November cuttings of Norway spruce and Korean fir rooted in larger percentages in sand watered from above than in sand subirrigated; that is, watered only from below.

Rooting of November cuttings of Norway spruce was decidedly improved by treatment with manganous sulfate 0.5 or 1.0 percent solution for 22 hours. Rooting of cuttings of Chinese juniper was much more improved by treatment with potassium nitrate 500 mg./l., 18 hr., preceding treatment with Hormodin No. 3 than it was by Hormodin No. 3 used alone.

Rooting of cuttings of black spruce and of 3 varieties of Norway spruce was improved or hastened by treatments with monobasic potassium phosphate 0.25 or 0.5 percent solution, 21 hours; and in the two cases where comparisons were made, indolebutyric acid was less effective.

Cuttings of Colorado fir and *Juniperus squamata* Lamb. rooted less well if allowed to lose 10 percent of their fresh weight before treatment.

Beach plum cuttings rooted well in 4 weeks after solution-immersion treatment with indolebutyric acid even though they were taken as late in the season as the last of June. For these cuttings taken relatively late, powder-dip treatments were less effective.

November cuttings of a hemlock treated with Hormodin No. 3 rooted 92 percent if from the north side of the tree, 25 percent if from the south side. November cuttings of a Norway spruce treated with manganous sulfate (1.0 percent solution, 19 hr.) rooted 50 percent if from the north side of the tree, 8 percent if from the south. December cuttings of arbor-vitae finally rooted 100 percent in any case, but those from the south side of the tree required 50 to 75 percent more days for rooting. Out of 31 possible comparisons with white pine cuttings taken in March from 3 different trees, cuttings from the north side of the trees rooted best in 17 cases, those from the south side in 7 cases, and there were no differences in 7 others.

Treatments of November cuttings of arbor-vitae (with indolebutyric and indolepropionic acids) which were apparently injurious in sand-sphagnum peat were not injurious in sand-sedge peat. November cuttings of Norway spruce rooted better in sand-sedge peat than in sand-sphagnum peat.

**Diseases of Plants Caused by Soil-infesting Organisms, with Particular Attention to Control Measures.** (W. L. Doran.) The effects of certain soil treatments on club-root of cabbage (caused by *Plasmodiophora brassicae* Wor.) were investigated. The disease was not prevented by ammonium sulfate (and lime), calcium cyanamide, or Fermate as used, but it was fairly well controlled by mercurous chloride 0.2 or 0.15 gm. per square foot without injury to growth of plants. Mercuric chloride similarly used retarded their growth. Sodium chloride used alone did not control club-root but 10.0 gm. per square foot appeared to be favorable to growth of plants and mercurous chloride gave rather better control when used with sodium chloride than when used without it. The percentages of infected plants were:

Soil Treatment	Percentage of Infected Plants
No treatment.....	95
Mercurous chloride 0.15 gram.....	33
Mercurous chloride 0.15 gram plus sodium chloride 10 grams.....	13
Mercurous chloride 0.2 gram.....	20
Mercurous chloride 0.2 gram plus sodium chloride 15 grams.....	0



Tomato seedlings emerged and grew more slowly if seeds treated with Arasan were planted in untreated soil than if untreated seeds were planted in soil which, immediately after seeding, received an application of formaldehyde, one teaspoonful per gallon of water. And, in untreated soil, tomato seedlings made more growth in their first three weeks if seeds had been treated with red cuprous oxide than if they had been treated with Arasan.

In soil heavily infested with damping-off fungi, principally species of *Pythium*, and having a relatively low moisture content at the time of seeding, there was usually less damping-off, and final stands of cabbage, tomato, pepper, lettuce, beet, and onion were usually much better if soil was not watered until 4 to 6 days after seeding, than if the soil was first watered immediately after seeding, as it commonly is. Similar postponement of the first watering after seeding also resulted in improved stands of *Aubrietia*, China aster, and zinnia.

Work done on the control of smut and pink root-rot of onion was with the cooperation of Thomas Sproston, Jr. A paper entitled, "Control of onion smut by fungicides applied to the soil" was presented at the Annual Meeting of the New England Division of the American Phytopathological Society. An abstract of this paper has been accepted for publication by Phytopathology. Onion smut, caused by *Urocystis cepulae* C. C. Frost, was well controlled by 58 pounds Fermate mixed with 1500 pounds of a 5-8-7 fertilizer per acre, applied immediately before seeding. Fertilizer used alone lessened the severity of smut but of course not enough. The percentage of seedlings which, in a typical instance, became infected with smut was 88 percent in a soil without treatment, 56 percent in this soil with fertilizer, and 1 percent in this soil with fertilizer to which Fermate had been added. Fermate so used was not injurious to growth of plants. There were comparable results when Arasan was similarly used. Smut was well controlled by Puratized N5-X and also by the nitrites of sodium and calcium, but Fermate used as above described gave better results. Urea and calcium cyanamide gave fair control but, as used, they caused some injury to onion seedlings.

Soil in which onions had grown poorly and in which they were known to have had pink root-rot, was variously treated before planting onion sets or sowing onion seeds in it. Numbers of onion seedlings which lived, as compared with numbers in untreated soil, were increased 80 percent by sodium nitrite, almost as much by Fermate. Fermate was ineffective, however, in preventing pink root-rot. But with pink root-rot severe on onions from sets in untreated soil (a species of *Fusarium* was isolated from diseased roots), the disease was at least partly controlled and early growth was markedly improved by copper sulfate 200 pounds or sodium nitrite 400 pounds per acre.

**Tomato Leaf Mold Caused by the Fungus *Cladosporium fulvum* Cke.** (E. F. Guba, Waltham.) Previous reports by the writer describe the discovery of resistance to all local strains of *Cladosporium* among certain primitive tomatoes received from the Division of Plant Exploration and Introduction, U. S. Department of Agriculture, and his progress in crossing these types with the Bay State variety. The Bay State tomato (Mass. Agr. Expt. Sta. Bul. 393) is now very susceptible to a variant strain of leaf mold.

The best approach to desirable types of greenhouse forcing tomatoes appeared among the progeny of successive generations of crosses of Bay State with a primitive type No. 129882 from Peru and No. 112215 from Ecuador.

A further series of crosses was made of selected lines of the above hybrids with Vetomold-121, Bay State, Waltham Forcing, and Marglobe. The crosses with No. 112215 are giving the best performance. The  $F_3$  generation will be grown in several commercial greenhouses for trial in the fall growing season

(1945), and for further selection to pure line the tomato for resistance and high yielding type.

Laboratory prepared dusts containing 5 percent Thiosan, Fermate, Spergon, or Dithane (HE-175), with 95 percent talc are fungicidal to *Cladosporium* spores. Dusts containing 10 percent active chemical and 90 percent talc gave satisfactory control of spore germination when a water suspension of spores was applied to dusted slides. The Dithane dusts were injurious to tomato foliage. The use of the tolerant dusts would appear to meet the demand for a suitable fungicide for the control of tomato leaf mold in the greenhouse.

**Causes and Control of Decay of Squash in Storage.** (E. F. Guba, Waltham.) The growing season was unusually dry. Six plots of Blue Hubbard squash were grown, each of an area of 7,350 square feet and comprising 34 hills. Three plots were sprayed five times with Bordeaux 4-4-50 mixture combined with calcium arsenate 1 pound and spreader; three similar plots were not sprayed. The unsprayed out-yielded the sprayed plots, thus confirming the results of the previous year. The residue of the spray persisting on the squash in storage would appear to provide some protection against decay organisms, but storage up to November 1944 showed no significant or consistent contrast among the six harvested lots of squash. Loss from decay was negligible. Shrinkage was greater among the stored squash from the sprayed than from the unsprayed plots. These results, at least in a real dry season, would appear to discourage field treatment with homemade Bordeaux mixture as a disease preventive treatment. Other types of fungicides are suggested for trial.

**Interrelation of Wettable Sulfur, Lead Arsenate and Lime in Apple Spraying.** (E. F. Guba and E. V. Seeler, Jr., Waltham.) This project is intended to improve upon our knowledge of the apple spraying schedule, involving the substitution of materials to avoid injury, selection of the best types of sulfur to insure the greatest protection against disease, selection of the most efficient fungicide for scab eradication, the effect on the adherence of sulfur of adding lead arsenate and lime, etc. As in the past, detailed reports are compiled and submitted to cooperating leaders.

The year 1944 was an off season for chemical russet injury on Red Delicious and no results were obtained. The usual amount of weather russet injury occurred on Golden Delicious, and as usual the greatest percentage of russeted apples occurred on the unsprayed trees. The season was too dry for an evaluation of the protective action of various sulfur pastes used. The destruction of scab spores on the foliage was best accomplished with lime sulfur 32° Be 2 gallons, Everett Flotation Sulfur Paste 16 pounds, and Fermate 1½ pounds to 100 gallons of water. The results with Wettable Spergon 2 pounds, HE-175 (Dithane) 1½ pounds, and DN-111 1¼ pounds to 100 gallons of water were unsatisfactory.

**Effect of Soil Temperature on Leaf Shape of Tobacco.** (L. H. Jones.) The effect of soil temperature on the shape of leaves of Havana Seed tobacco has been found to occur in the absence of a mosaic virus. The apparatus provided two constant soil temperatures, a low at 70°F. and a high at 90°F. At the low temperature the leaves developed consistently as the normal ovate shape. At the high temperature the newer leaves appeared yellow spotted, light green in color, narrow, and very pointed, fitting the description of what is called frenching in tobacco. Inoculation of healthy plants with the leaf juice of these frenching leaves failed to result in the development of any symptoms of a mosaic virus, while comparable healthy plants did develop mosaic symptoms when inoculated with the juice of mosaic-affected leaves.

Changing the soil temperatures from the low to high and from the high to low altered the shape of the new leaves formed after the change of temperatures. Those plants which had been growing at the low of 70°F. with normal leaves soon produced frenched leaves at the tip when the soil temperature was raised to 90°F. On the other hand those plants which had been growing at 90°F. soil temperature and had produced frenched leaves at the tip reacted to the dropping of the soil temperature to 70°F. by sending out lateral shoots, the lower leaves of which were frenched but as the shoot grew the leaves developed with less frenching and were practically normal at the tip.

**Toxic Effect on Plants by Wood Preservatives.** (L. H. Jones.) Continuation of the work previously reported on creosote injury to plants showed that the injury was local. The fumes are evolved from creosote-treated lumber by the high temperature of the sun's rays and pass into the leaves of plants through the stomata. An exposed leaf on a vine or stem may be killed, but the creosote fumes are not transmitted by the vascular system to adjacent parts. However, if the injury is in the region of the growing point, further growth is stopped and the plant will die unless the nature of the plant allows the development of lateral shoots, one of which may become a leader.

No injury resulted from attempts to have creosote or its fumes absorbed through roots of plants in the soil. Seedlings of cabbage protected from creosote fumes by glass shells were uninjured although the creosote fumes were free to enter the soil and be absorbed by roots. One teaspoonful of creosote mixed with the volume of soil in a 3-inch pot failed to give injury even with a recorded soil temperature of 108°F. Creosoted tomato stakes with the creosote slightly above the soil line did no harm to plants, when young or at any time during the season.

Cabbage maggot protectors made of heavy paper impregnated with creosote did not injure cruciferous plants except when the stalks were soft and tender. Unhardened plants were liable to be burned by the fumes where the impregnated paper came in contact with the stalk. Injury also occurred when growers failed to remove translucent hoods before the sun's rays became strong enough to volatilize the gases of creosote in the paper, which were then confined under the hoods. Tests made with these protectors tacked to lath and placed close to radish rows resulted in injury to the radish plants. Even after the radish plant had four true leaves and was four inches high, injury resulted and the leaves were severely injured. Probably the closeness of the leaves did not allow good air drainage and the fumes collected about the leaves.

Lumber with the trade name of Asidbar, impregnated with resins from which the more volatile constituents had been removed, was injurious to seedlings of cabbage and tomato when the lumber was at a higher level than the seedlings. The injury was similar to creosote injury, resulting in a rolling upward and inward of the margins of the cotyledons and first leaves of cabbage and tomato. Death of the seedlings was frequent. Injury did not appear during cloudy weather but followed hot sunny days, indicating that some fumes are evolved by the influence of the sun's rays. Asidbar lumber buried in the soil in close proximity to seeds of tomato and cabbage gave no indication of a toxic effect. In fact the roots of the seedlings developed in contact with the wood, remained white and developed branches in contact with the wood. A recorded soil temperature of 96°F. on a hot day was not followed by any indication of injury from this lumber protected from the sun's rays by the soil covering.

Cuprinol, a copper naphthenate, when used as a wood-preservative paint did not injure plants. Before plants or seeds were used near the painted wood, a week was allowed to elapse in order that the volatile carriers of the preservative might evaporate.



**Chlorine Injury to Plants.** (M. A. McKenzie and L. H. Jones.) Following investigation of a tree trouble which proved to be of non-parasitic origin, the possible involvement of escaping gas from a nearby chlorinator led to an investigation of the effect of chlorine on woody plants. Available literature on chlorine in relation to plants concerns chiefly chlorine in water used on soil in which plants were growing. In conformity with common opinion, no injury was observed when potted plants were watered with a mixture of chlorine and water applied only to the soil. Injury<sup>1</sup> did occur, however, when an equal quantity of the same mixture was applied directly to the foliage.

**Resistance to *Fusarium dianthi*.** Prill. et Del., the cause of a serious carnation wilt disease. (E. F. Guba, Waltham.) The reaction of many standard varieties of carnations (*Dianthus caryophyllus* L.) to *F. dianthi* has been determined by artificial inoculation methods. Selected varieties showing a highly resistant reaction to the branch rot fungus will be selfed and crossed for a similar analysis of the progeny. The wilt-resisting seedlings will be carried to flowering in search of types meeting commercial standards.

Both Arasan (tetramethylthiuram disulfide) and Fermate (ferric dimethyl-dithiocarbamate) in mixtures of 10 percent with 90 percent talc gave good control of *Fusarium* wilt in the propagating sand when the basal end of artificially inoculated cuttings was treated with the chemical dust before the cuttings were planted. A mixture of either of these fungicides with hormone dust in the ratio of 10-90 respectively for a combined disease control and root inducing effect is indicated.

Considerable time was devoted to the preparation of a Station bulletin on the subject of carnation wilt diseases and their control.

**Miscellaneous Studies.** (E. F. Guba and E. V. Seeler, Jr., Waltham.)

**Damping-Off Control with Seed-Borne Chemicals.** As in previous years the various dry chemical seed treatments were tested for their control of damping-off of vegetable stands. The cold temperatures and abundant rainfall prevailing throughout the vegetable seed sowing season were ideal for these tests. The results will be compared with those of previous years and the preferred treatments arranged in a chart or guide for market gardeners.

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## DEPARTMENT OF CHEMISTRY

Walter S. Ritchie in Charge

**Studies on the Quantitative Estimation of Hemicelluloses.** (Emmett Bennett.) Hemicelluloses constitute one of the largest single group of substances in plant material, but because of the association with other compounds and the heterogeneity of the substances, their determination is one of the least satisfactory to make. After making other preliminary tests utilizing the charge on the hemicellulosic particle as a basis, it seems more advantageous to start with the holocellulosic material. Preliminary experiments indicate that sodium chlorite can be used effectively in preparing the holocellulosic fraction from non-woody plant tissue for the quantitative estimation of hemicelluloses. This procedure, while long, is simple, requires little attention, and eliminates other more tedious and lengthy operations. The resulting product is substantially free of lignin and contains the hemicelluloses. No statement concerning the actual quantitative estimation is warranted at this time.

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<sup>1</sup>Jones, L. H., and McKenzie, M. A. Chlorine gas injures trees. *Arborist's News* 9:89-90. 1944. (Mass. Agr. Expt. Sta. Contrib. 541).



**The Chemical Investigations of Hemicelluloses.** (Emmett Bennett.) Hemicelluloses were isolated from corn cobs and rye straw by the alkali method. Hypochlorites and bromine were used in purifications. The purified substances were subjected to chemical treatment which would indicate some facts regarding their chemical nature. The results of these investigations seem to indicate the following:

(a) Xylose appears to be the chief sugar present in both preparations. A uronic acid, believed to be glucuronic acid, was also present in both samples. Glucose was present but galactose could not be detected.

(b) As indicated by acetylations, corncob hemicellulose has two free hydroxyl groups. The theoretical acetyl content of  $C_9H_{12}O_6$  is 39.81 percent; the prepared product contained 39.73 percent. The theoretical and actual carbon content of the acetate are 49.98 and 49.50 percent respectively. These data indicate that the xylose units probably are linked through the 1, 4 positions and that the preparation was quite pure. Hemicellulose from rye straw does not acetylate satisfactorily.

(c) The "repeating units" appear to be of from 25 to 40 units in length, corresponding to an approximate molecular weight of from 3000-6000.

(d) Hydrolytic and polariscopic studies indicate that the xylose units in both hemicelluloses have a pyranose structure with a beta-type linkage between units.

(e) Alkali-lability numbers are about equal and are comparable to those of commercial samples of corn starch.

(f) Complete hydrolysis of both hemicelluloses could be obtained with 4 percent sulfuric acid in approximately four hours, whereas the usual time is about 15 hours. This shorter time of hydrolysis decreases the destruction of uronic acids.

**The Investigation of Agricultural Waste Products.—1, The Chemical Investigation of Lignin.** (Emmett Bennett.) The work on this project to date has been devoted to ascertaining the effect of large quantities of pure lignin upon the aerobic decomposition of plant materials of varying composition.

Pure lignin was added to finely ground samples of silage, timothy hay, corn stalks, and oat hay, thoroughly mixed, inoculated with a soil suspension, and allowed to incubate at about 32°C. for several months. The lignin contained 64.2 percent of carbon and 5.6 percent of hydrogen and was added in amounts equivalent to about 14 percent of the plant material. In order to increase the supply of nitrogen for microbial activity one gram of nitrogen in the form of ammonium carbonate was added to each 100 grams of organic material. Controls were used in each case. At definite intervals, representative samples were removed and analyzed for total nitrogen, ammoniacal nitrogen, solids, and pH.

Tentative results indicate that there was a greater loss of organic matter from the corn stalks and oat hay in the presence of added lignin: timothy hay and silage decomposed at about the same rate with or without lignin. In general, ammonification was retarded in the presence of lignin.

Although we have no data on the influence of the products of decomposition on the vigor of the plant, it would seem that added lignin does not materially alter the rate of the aerobic decomposition of plant material if sufficient nitrogen is available.

**Factors Affecting the Vitamin Content of Milk and Milk Products.** (Arthur D. Holmes.) Milk, which has been described as nature's most perfect food, is of especial importance to the residents of Massachusetts. From the farmers' viewpoint, it is one of the principal agricultural products of the State and it is highly

important to the consumer since it is a particularly valuable food which is consumed in such large amounts that a great deal is imported from other areas to supplement that produced in Massachusetts. Obviously many factors affect the vitamin content of milk, but recently attention has been largely centered upon the influence of the ration and the effect of sunshine on cow's milk and a study has been made of the vitamin content of goat's milk collected from numerous areas of the State.

*The Ratio of Ascorbic, Nicotinic, and Pantothenic Acids, Riboflavin, and Thiamine in Late Summer Milk.* (Arthur D. Holmes, Carleton P. Jones, Anne W. Wertz, Katherine Esselen, and Beula V. McKey.) The milk used in this study was produced by the college herd of Ayrshire, Guernsey, Holstein, Jersey, and Shorthorn cows in the late summer when the pasture grasses were fully mature, but before severe frosts had affected their quality. The pasture ration was supplemented with ground grains (14 percent) at the rate of one pound for each six pounds of milk the cows produced. Fifteen samples of milk, which represented 15 days' production, were assayed. The values obtained varied somewhat from day to day, but averaged ascorbic acid 18.4 mg., nicotinic acid 1.1 mg., pantothenic acid 3.66 mg., riboflavin 1.37 mg., and thiamine 0.44 mg. per liter. Judged by the dietary allowances recommended by the National Research Council, such milk would have to be fortified with ascorbic and nicotinic acids to meet the recommended allowance for infant feeding.

*Effect of Sunshine upon the Ascorbic Acid and Riboflavin Content of Milk.* (Arthur D. Holmes and Carleton P. Jones.) It has long been known that sunshine or strong light tends to destroy ascorbic acid and riboflavin. Accordingly, it appeared desirable to determine the extent to which sunshine might reduce the nutritive value of milk by destroying these vitamins. Similar studies had been reported from other laboratories, but unfortunately the authors did not measure the sunshine to which their samples of milk were exposed. Accordingly, milk produced by the college herd was exposed to the action of sunshine for two 30- or two 60-minute periods in  $\frac{1}{2}$  pint commercial milk bottles. The intensity of the sunshine was measured with a pyrheliometer equipped with an automatic recording device. The "sunshine" varied from a total of 4.8 gm. cal. per sq. cm. on a rainy day to 144.6 gm. cal. per sq. cm. on a bright day. The temperature of the milk varied from day to day depending upon the velocity of the wind, greenhouse effect of the milk bottles, and intensity of the sunshine. The destruction of reduced ascorbic acid was very rapid. Little, if any, was present after 30 minutes' exposure. The riboflavin disappeared more slowly. A 10 percent loss occurred during 60-minutes' exposure on a rainy day and 85 percent disappeared during exposure to bright sunshine for 120 minutes. These data show that milk allowed to stand for more than a short period on the consumer's doorstep exposed to strong light or sunshine, is likely to lose a large amount of its ascorbic acid and riboflavin.

*The Vitamin Content of Commercial Winter Goat's Milk.* (Arthur D. Holmes, Harry G. Lindquist, Carleton P. Jones, Anne W. Wertz, Katherine Esselen, Beula V. McKey, and Evelyn Fuller.) It has been estimated that the retail value of goat's milk produced in this country exceeds \$100,000,000 annually. A large portion of the fluid milk is used for infants, for invalids, and for consumption in the home of the producer. However, a review of the literature revealed very little information on the vitamin content of goat's milk. Accordingly, 18 samples of raw goat's milk from various localities within 100 miles of Amherst were assayed. Data were collected concerning the breed of the goats, their age and stage of lactation, and their ration. The average values obtained were fat

4 percent, bacteria 1300 per cc., ascorbic acid 6.5 mg., nicotinic acid 2.96 mg., pantothenic acid, 3.38 mg., riboflavin 1.25 mg., and thiamine 0.47 mg. per liter. These results show that goat's milk is a very valuable source of the vitamins noted above.

*The Variation in the Bacteria, Fat, Ascorbic Acid, and Riboflavin Content of Goat's Milk.* (Arthur D. Holmes, Harry G. Lindquist, and Elliott K. Greenwood.) The present curtailed supply of milk and milk products in Massachusetts has stimulated the use of goat's milk instead of cow's milk, particularly in families of foreign birth or ancestry. Coincident with the increase in the number of goats and in the number of consumers of goat's milk, there has been an increasing demand for information regarding the nutritive value of goat's milk. Accordingly, 39 samples of goat's milk were obtained from various localities throughout the State. They were shipped to the laboratory carefully packed in ice and the temperature on arrival was 34°-40°F. Sixty percent of the samples represented a single milking of one animal, but the other samples were composites of milk from herds of 8, 19, 50, and 65 goats. Four breeds of goats were represented, French Alpine, Nubian, Saanen, and Toggenburg. Their ages varied from 1 to 12 years and the stage of lactation varied from 10 days to 36 months. None of the goats received any corn or grass silage. The majority were stall-fed, but 14 of the samples were from goats that also received various herbage varying from buds and twigs of bushes to good Ladino clover, timothy, and red top pasture. The bacteria count varied from 20 to 21,300 per cc. The average for 38 samples was 3,500 per cc. or practically only 1/3 that allowed for certified cow's milk. The fat content varied from 2.2 to 6.5 percent and averaged 4.3. The reduced ascorbic acid of milk from the stall-fed goats averaged 15.1 mg. and that from the goats which received some pasture averaged 20.0 mg. per liter. The riboflavin content of the milk from the stall-fed goats averaged 1.24 mg. per liter, which is identical with that obtained in a previous study. The average riboflavin content of the milk from goats which had access to pasture was 1.02 mg. per liter, which is in accord with another observation that the riboflavin content of cow's milk decreased from 1.43 mg. to 1.26 mg. per liter when a mixed herd of cows was changed from a ration of hay, silage, and grain to a pasture of young, rapidly growing green grass. Apparently the bacteria count, fat, ascorbic acid, and riboflavin content of goat's milk vary considerably with the source of the milk. These results also show that the goat's milk under consideration contained fewer bacteria and less riboflavin, but about the same amount of fat and ascorbic acid as cow's milk.

*Influence of Calcium and Magnesium upon Composition of Boston Head Lettuce.* (Arthur D. Holmes and Leo V. Crowley.) For many years lettuce has been classed as a protective food since it contains minerals and vitamins which are not present in adequate amounts in carbohydrate-rich and fat-rich foods. While meat and dairy products are relatively rich sources of minerals and vitamins, they are much more expensive and at the present time can be purchased in only limited amounts. Commercial and practical gardeners are of the opinion that frequently the quality and yield of lettuce can be enhanced by supplementing the usual lettuce fertilizers with lime or lime and magnesium. Accordingly, a study was undertaken to determine whether the mineral and vitamin content of lettuce may be significantly influenced by the use of these supplementary fertilizers which were applied at the rate of 150 pounds of magnesium sulfate per acre, 1,000 pounds of limestone per acre, and a combination of 150 pounds of magnesium sulfate and 1,000 pounds of limestone per acre. The use of magnesium sulfate as a supplementary fertilizer increased the magnesium content



of the lettuce but it also reduced the calcium, iron, and phosphorus content. The use of magnesium sulfate and lime or lime alone as a supplementary fertilizer tended to reduce the carotene, calcium, iron, and phosphorus content of the lettuce and caused a definite decrease in the magnesium content. The values obtained show lettuce to be a valuable source of carotene, riboflavin, calcium, iron, magnesium, and phosphorus and to be well deserving of its classification as a "protective food" for the human dietary.

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### CONTROL SERVICES

Philip H. Smith in Charge

The fertilizer, feed, seed and milk testing laws are administered as one service and the operations of each of these, with the exception of the milk testing law, are reported in annual bulletins issued for that purpose.

Under the milk testing law 6,407 pieces of Babcock glassware were tested for accuracy and 85 certificates of proficiency in testing were issued. In addition, all milk depots and milk laboratories in the State were visited at least once, as required by statute, in order to check apparatus and the general conduct of the work. In order to promote greater efficiency in checking on the accuracy of testing, the field men of the Milk Control Board have been deputized to conduct investigations. This is authorized by law.

In addition to regular routine duties, Control Service has been called upon to the extent of time available to assist other departments of the College and Station in conducting work in connection with research problems not originating in the Control department itself. Such service has been rendered during the past year to the Departments of Pomology, Olericulture, Animal Husbandry, Veterinary Science, Agronomy, Poultry Husbandry, Dairy Industry, Waltham Field Station, Food Technology, and Research Chemistry.

Considerable time has been devoted to assays and analyses not directly connected with the requirements of the several acts but for which there appears to be need. Some of the work covered has been assays for riboflavin, carotene, choline, and trace mineral elements in feeds.

Control Service has also examined feeds and fertilizers submitted by citizens of the State and State Institutions. Where such work can be construed to be of general public value no charge is made.

The work of the Seed Laboratory continues to enlarge, not only on account of the temporary increase in War Gardens, but also because of a growing realization on the part of retail seed dealers that good seed is of prime importance if a good crop is to be expected. Each year retailers in growing numbers submit, prior to sale, the seed they expect to offer. During the year a new seed germination room has been installed which greatly facilitates the testing of the larger field and garden seeds.

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### THE CRANBERRY STATION

East Wareham, Massachusetts

H. J. Franklin in Charge

**Injurious and Beneficial Insects Affecting the Cranberry.** (H. J. Franklin.)

*Hill Fireworm (Tlasca finitella).* There were plenty of these worms on the heavily vined Burrage bog at South Hanson, in June, 1944. Cryolite, 50 pounds to the acre applied as a dust on June 28, gave excellent control of the pest.



*Cranberry Spittle Insect (Clastoptera saint-cyri)*. This insect began to hatch on Cape Cod cranberry bogs as early as May 31, in 1944.

*Armyworm (Cirphis unipuncta)*. This worm appeared in numbers on many cranberry bogs from which the winter water was let off as early as May 20 in the spring of 1945.

*New Insecticides*. During the 1944 growing season, tests of sabadilla and DDT as possible controls of various cranberry pests were made in cooperation with the United States Bureau of Entomology, with the following results:

*Sabadilla* in all cases was used as a 20 percent dust. At the rate of 75 pounds per acre, this dust was fully effective against the black-headed fireworm (*Rhopobota*); and at 100 pounds per acre it controlled the blunt-nosed leafhopper (*Ophiola*) reasonably well. Smaller amounts were not enough. At the rate of 100 pounds per acre, it was wholly ineffective as a treatment for the cranberry fruit worm (*Mineola*), and killed only about two thirds of the cranberry girdler (*Crambus*) moths treated.

No injury to cranberry vines or blossoms from sabadilla was observed. It was not liked by the growers because of its sternutative effects on those handling it. This seems to be a fair stop-gap insecticide for the black-headed fireworm and blunt-nosed leafhopper, but probably will never have permanent value as a cranberry insecticide.

*DDT*. Fifty pounds of 3 percent dust to an acre was fully effective against full - grown gypsy moth caterpillars and the blunt - nosed leafhopper, lesser strengths not being clearly satisfactory. The 5 percent dust at the rate of 100 pounds to the acre was 80 percent effective against the cranberry fruit worm, but was clearly less satisfactory than derris or cryolite. The 5 percent dust at the rate of 100 pounds per acre, used after the flight of the moths, killed about 75 percent of the small worms of the cranberry girdler on the bog floor. No evidence appeared that DDT is injurious to cranberries at the strengths and in the amounts used. The bee situation is such that it seems dangerous to advocate the use of this material on cranberry bogs even against pests which it controls readily.

*Prevalence of Cranberry Insects*. The relative general abundance of cranberry insects in the 1944 season was as follows:

1. Gypsy moth infestation relatively fairly heavy throughout the cranberry section of southeastern Massachusetts.

2. Blunt-nosed leafhopper (*Ophiola*) well controlled and rather scarce everywhere on the bogs.

3. Cranberry fruit worm (*Mineola*) extremely abundant and destructive everywhere in southeastern Massachusetts except in Bristol County, more so than for many years. It may be worth noting that a similar insect, the codling moth, was also very abundant in New England this year. The fruit worm was not noticeably prevalent on bogs in Middlesex County.

4. Black-headed fireworm less troublesome than usual.

5. No firebeetles (*Cryptcephalus*) found.

6. Spanworms in general not plentiful.

7. False armyworm (*Xylena*) normal in abundance.

8. Black cutworms (*Euxoa<sup>1</sup> ypsilon*) very abundant after summer flooding of bogs to control grubs.

9. Cranberry girdler (*Crambus*) very plentiful and troublesome, due probably to reduced resanding and fall flooding caused by labor scarcity, a war condition.

<sup>1</sup>Essig, College Entomology, 1942, p. 476.

10. Infestations of cranberry weevil, cranberry spittle insect, and tipworm about normal.

11. Honeybees and bumblebees normally prevalent.

**Weather Studies.** (H. J. Franklin.) Further studies since Bulletin 402 was published in 1943 have produced additional material which has resulted in the revision of the formulas for use in reckoning minimum bog temperatures with the 7 p.m. weather data.

**Winterkilling.** Cranberry winterkilling in Massachusetts in the winter of 1943-44 was the most extensive and severe in the memory of the oldest growers, causing an estimated reduction in the 1944 crop of at least 30 percent. On many bogs the vines were all killed down to the ground. The extent of this damage was not surprising, for a much larger cranberry acreage than usual was not flooded when it should have been because of the lack of enough rain to build up water supplies in the fall and early winter.

The severe frost of May 18-19, which cut off all the new growth that had developed on the winterkilled bogs up to that time, and the severe drouth that prevailed most of the summer were very unfavorable to good recovery of the injured vines. In spite of this, the new vine growth by fall was satisfactory on nearly all of the damaged areas. Some growers tried to help their bogs recover by mowing off the dead vines, resanding, or fertilizing, but there is little evidence that any of these measures was definitely beneficial. They had generally resulted in an undesirable growth of runners.

**Frost.** The frost on the night of May 18-19, 1944, considering the date of its occurrence and the minimum bog temperatures reached (from 14° to 25° F.), was one of the most severe in Massachusetts cranberry history. It killed all the season's new cranberry growth on many bogs and caused the old cranberry foliage on a few small areas to turn dark again as in winter. The extensive injury from this frost was due partly to lack of water for flooding and partly to freezing of the vines over the frost flood on some of the colder bogs. Also, since most of the bogs were very dry and absorbed much more water than usual, many did not get flooded as soon as they should have been. It was difficult to estimate the damage to the 1944 crop because of the extensive injury from winterkilling.

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## DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

**Sterilizing Agents for Dairy Use.** (W. S. Mueller, J. E. Fuller, and E. Bennett.) The search for new sterilizing agents which will be practical for dairy equipment was continued during the past year. A sterilizing agent for dairy use should be (1) highly germicidal in the presence of organic matter, (2) non-corrosive to metals and rubber, (3) low in cost, and (4) non-toxic to humans. The germicidal properties of 42 materials obtained from 14 manufacturers have been studied. Where the manufacturer recommended the concentration to be used, the recommendations were followed; otherwise, the material was used in 0.05 percent and 0.5 percent concentrations, and in some cases 1 percent was also used. The sterilizing properties of solutions of the different materials were determined by adding 1 ml. of raw milk to 99 ml. of the solution to be tested. After the milk had been in contact with the solution for 5 minutes, proper dilutions were made and 1 ml. quantities were plated according to the Standard Method for Milk Analysis procedure. Out of the 42 materials, 15 were effective as sterilizing agents, 7 were moderately effective, and 20 were ineffective. The classification of the materials into groups and the germicidal properties of the various groups were as follows:

Group	Effective	Moderately Effective	Ineffective	Total
Germicides and fungicides.....	6	2	2	10
Wetting agents.....	3	0	6	9
Surface active agents.....	3	0	2	5
Dispersing agents.....	0	4	0	4
Emulsifying agents.....	0	0	4	4
Detergents.....	0	1	1	2
Contact insecticides.....	0	0	1	1
Insecticidal spreading agent.....	0	0	1	1
Unknowns.....	3	0	3	6
	15	7	20	42

Of the effective and moderately effective materials, 3 are substituted phenols, 7 are quaternary ammonium compounds, 3 are phosphonium compounds, 8 are alkyl aryl sulfonates, and 1 is an aliphatic sulfonate.

All of the effective sterilizing materials were non-corrosive to 18-8 stainless steel, but three were objectionably corrosive to monel metal.

The results to date indicate that, of the 42 materials investigated, three have possibilities of being equal to or better than chlorine for sterilizing dairy equipment, and some may have a place in conjunction with cleansing agents.

**Improving the Flavor and Keeping Properties of Milk and Some of Its Products.** (W. S. Mueller.) The only sure means of preventing the oxidation of fat in dairy products is to remove practically all of the oxygen from the container in which the product is packed and to replace it with an inert gas. Because of the difficulties involved, manufacturing procedures would be simplified if the same results could be obtained by the use of an antioxidant. During the past year the value of cacao shell and cocoa powder as antioxidants has been studied.

Sixteen different extracts of cacao shell and cocoa powder were prepared and tested, together with a number of other materials. Two accelerated tests, known as the Swift Fat Stability Test and the Incubation Test, were used, and the materials are listed in decreasing order of effectiveness in butter oil: Caffeic acid, gallic acid, nordihydroguaiaretic acid (N.D.G.A.), propyl gallate, tannic acid, tocopherol, palmatal-l-ascorbic acid, tetrachloropara-benzoquinone, and Viobin. The best antioxidant obtained from cacao products falls near the middle of this group. While the cacao antioxidant was not so effective as some of the other materials studied, it did have some advantages. For instance, it did not impart a foreign flavor to the butter oil, while caffeic acid, gallic acid, N.D.G.A., propyl gallate, tannic acid, and tocopherol, in equal amounts, gave an objectionable flavor; also, it was most effective in the presence of copper, which is significant because some dairy products contain 4 or more p.p.m. of copper when packed for storage.

The antioxidants were used only in accelerated tests, and final conclusions cannot be drawn until long keeping tests have been made on dried ice cream mix, dried milk, butter, and butter-type spreads.

**Study of Packaged Ice Cream.** (J. H. Frandsen.) Results of scorings this year indicate that bulk ice cream is more palatable than packaged ice cream as generally found on the market. The results are only preliminary, and further studies will be made in an effort to develop a packaged product that will be as palatable as bulk ice cream. When this is accomplished, it will probably result in a very much larger percentage of ice cream being sold in packaged form.

Packaged ice cream can be handled with less shrinkage and less labor than bulk ice cream. Machine-packaged ice cream can be kept at a lower temperature than bulk ice cream, and therefore keeps in better condition after it is sold to the consumer.



## DEPARTMENT OF ECONOMICS

Philip L. Gamble in Charge

**Effects of the War and Readjustments in Massachusetts Agriculture.** (David Rozman.) Work on this project centered largely on investigation of undeveloped rural land areas as a possible factor in desirable land use adjustment of farming units in the post-war period. An intensive phase of this study was carried out in the towns of Uxbridge, Hubbardston, and Southwick. Further analysis was made of AAA records and other current material in determining the trend and volume of Massachusetts agricultural production.

The preliminary results of the land use factor, especially as derived from an intensive study of the towns of Uxbridge, Hubbardston, and Southwick, indicate that undeveloped areas not in farms offer considerable opportunities for possible readjustment of existing farm units. In some favorably located areas opportunities are also present for a limited number of additional farms. The limiting factors are an irregular distribution of available land, the complicated pattern of land ownership, and the cost of bringing the land into use.

The findings under this project bearing on the major factors involved in agricultural production are of continuous importance in achieving the desirable pattern of Massachusetts agriculture under wartime conditions. They are expected also to pave the way for an orderly transition to peacetime conditions and for placing agriculture in the State on a more stable basis.

In connection with this program of readjustment of Massachusetts agriculture the manuscripts prepared are: (a) 1945 Wartime Production Capacity of Massachusetts Agriculture; and (b) A Post-War Production Pattern for Massachusetts Agriculture.

## DEPARTMENT OF ENGINEERING

C. I. Gunness in Charge

**Cranberry Storage Investigation.** (C. I. Gunness, H. J. Franklin, and H. F. Bergman.) The storage of cranberries was continued during the 1944 season. Berries were stored at 45 degrees in a normal atmosphere and also in a controlled atmosphere where the carbon dioxide content was kept at approximately 10 percent, oxygen at 10 percent, and the balance was nitrogen. Berries similar to those stored at 45 degrees were also stored in an air-cooled screenhouse. The berries were picked and stored on September 9 but the controlled-atmosphere room was not sealed until September 11.

On September 14 the hurricane disrupted power service and service was not restored until September 25. The temperature rose to 53 degrees in the two rooms which were supposed to be kept at 45 degrees.

The storage losses as determined by screening on October 6 were as follows: 45-degree room, normal atmosphere, 4.4 percent; 45-degree room, controlled atmosphere, 2.9 percent; screenhouse, 7.1 percent. Berries stored in the controlled atmosphere had colored less than those stored in normal atmosphere. In comparing loss in the screenhouse with that in the rooms held at 45 degrees, it should be recalled that the temperature in the latter rooms actually rose to 53 degrees between September 14 and September 25.

**Poultry House Investigation.** (C. I. Gunness and W. C. Sanctuary.) The poultry housing studies were continued during 1944-45 with special emphasis on ventilation and arrangement of equipment to permit a reduction in the num-



ber of square feet allowed per bird in the pen. The electric ventilation system was rebuilt so as to use a smaller duct, and the outlet from the duct increased in size to reduce drafts across the floor. The main features of circulating a relatively large volume of air across the floor and the introduction of a small amount of fresh air were retained. Windows were kept closed throughout the season, the sole intake of air being through a 6" pipe in a pen housing 100 birds. Temperatures were kept higher than would have been possible in this uninsulated house with slot or window ventilation. Litter remained good.

In another pen, slot ventilators were baffled, which permitted placing roosts and elevated feed hoppers well toward the front of the house without fear of drafts. The new arrangement permitted increasing the number of birds until only 3 square feet of floor space per bird was allowed in place of the conventional 4 square feet. This was accomplished without sacrificing the health of the birds or loss of egg production.

**Hay Drying.** (C. I. Gunness, J. G. Archibald, C. H. Parsons.) Equipment was installed in one of the college barns in 1944 for curing hay partially cured in the field. A system of ducts was installed on the barn floor and air blown into these ducts, the air being forced up through the partially cured hay. About 40 tons of hay were cured, the greater portion of which was put into the barn with a moisture content of 45 percent. The hay was cured satisfactorily and indications are that this system can be used in New England with considerable success.

The trial is continued during the current season and another installation has been made for curing baled hay.

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## DEPARTMENT OF ENTOMOLOGY

Charles P. Alexander in Charge

**Investigation of Materials which Promise Value in Insect Control.** (A. I. Bourne and W. D. Whitcomb.) Work in connection with the cooperative project with the Dow Chemical Company was continued, both at Amherst and Waltham.

Tests in different blocks of the college orchard and in nearby commercial orchards supported previous results and showed that DN-111 or D-4 properly applied were dependable to a very high degree in subduing summer outbreaks of European red mite. In one of the experimental blocks in which tests were being made of DDT as a replacement of lead arsenate, red mite apparently suffered no inconvenience from repeated applications of DDT and by early July had increased to an average of 175 mites per leaf. DN-111 in one application reduced the population to an average of 1.5 mites per leaf within 24 hours, and no serious later build-up took place.

DN-111 and D-4 applied to beach plums heavily infested with red mite reduced the mites almost to the point of extinction.

In several commercial orchards the owner applied DN-111 following standard directions and secured as satisfactory control as in our own test blocks. This supported our contention that, if the material is thoroughly applied (trees sprayed from the ground), DN-111 can be expected to give a high degree of control, and that D-4 dust will give practically as good results if sufficient time is taken to insure thorough coverage.

Trees of Wealthy, Cortland, and Baldwin varieties were given 5 applications of DN-111 plus wettable sulfur plus lead arsenate between May 20 and August 11. No injury was noted on any variety. The season of 1944 was not of a type to induce spray burn of any type so that while these tests are encouraging they need to be supported by further work in a more normal year.

Tolerance tests of DN-111 and lead arsenate and wettable sulfur were made on peaches, plums, and cherries. Two applications were made: the first, an equivalent of late shuck spray, on May 29, and a later spray on July 13. No injury was noted.

Tolerance tests of both DN-111 and D-4 were made on 10 different types of ornamentals during the period between May 31 and July 18. Considerable foliage injury was observed on several plants following the May application. Unmistakable burning, though less severe, resulted from early June application. Injury was noticeably less following late June application, and very little or no injury resulted, even on susceptible varieties, following July applications.

The scarcity of apple leafhoppers in both early and late season throughout the State made it impossible to run the tests planned against these insects.

At Waltham, dormant applications to apples having a light infestation of overwintering red mite eggs resulted in a reduction of live mites on May 16 from 170 mites per 100 spurs where no treatment was applied to 39 mites per 100 spurs following miscible oil 3.3 percent actual oil, and to 129 mites per 100 spurs following DNOC powder at the rate of 3 pounds in 100 gallons. By August 1 no significant difference in the number of mites was found, indicating that the effect of the dormant spray had been lost.

**Studies of Different Forms of DDT.** (A. I. Bourne and W. D. Whitcomb.) The work on DDT in its various forms was conducted in cooperation with the Crop Protection Institute, and all of the materials were furnished by the Geigy Company, Inc., New York City. Tests of DDT were made in all of the outstanding field projects and are reported under those projects, and in addition special laboratory and field tests were made on as many particular species of insect pests as possible.

*Rose Chafer.* In laboratory tests Gesarol A-20 and A-3 gave very promising results against rose chafer. In the first series of tests the materials were applied in a light application to grape foliage, and beetles were then placed on the leaves. In 6 days 90 percent of the beetles on dusted foliage were dead and only 50 percent on sprayed leaves. In a second test, foliage was given a heavy dusting with A-3, and 80 percent of the beetles were dead after 2 days and 90 percent at the end of 3 days. In a series in which the beetles were sprayed or dusted and then placed on grape foliage which was also sprayed or dusted, 90 percent of the sprayed beetles and all of the dusted beetles had died by the second day. In a fourth series, beetles were sprayed or dusted and placed on untreated grape foliage. After 2 days 80 percent of the dusted beetles and 74 percent of the sprayed beetles were dead, and at the end of 5 days all had died. In this time 4 percent of the untreated beetles died in the 2-day period, 2 percent more after 3 days, and 10 percent at the 5-day period.

*Japanese Beetle.* Gesarol A-20 spray and Gesarol A-3 dust were fully as effective against Japanese beetles as against rose chafer. The beetles seemed to be rendered inactive within a few hours after treatment and no recovery was noted. In all cases the beetles had been treated and then placed on fresh foliage.

In a comparison of DDT with other insecticides, all beetles treated with DDT spray or dust were dead by the second day, while all were alive in lots treated with cryolite spray and copper rotenone dust. In the lot treated with Lethane B-72, 20 percent of the beetles were dead after 2 days and most of the remaining beetles were more or less inactive. During this period of 2 days, only 3 percent of the untreated beetles had succumbed.

*Striped Cucumber Beetle.* DDT was very toxic to striped cucumber beetles. Within a short time after treatment the beetles became inactive and ceased feeding, and in 24 hours all were dead, while all beetles dusted with rotenone succumbed within 12 hours. DDT was not quite so rapid in its actual killing effects as rotenone; but since all treated beetles ceased feeding and became inactive within a few hours after treatment, from a commercial standpoint they ceased to function as pests so that the actual time of death was of secondary importance. No injury to foliage was noted in laboratory tests. The beetles appeared late in the season when the plants had made considerable growth and no injury from the treatment was observed such as was reported from tests in other states where applications were made in early season when the plants were small and very tender.

*Squash Bug.* This insect was relatively scarce in the vicinity of Amherst and only laboratory tests on a few specimens were possible. In each series DDT killed young-stage bugs up to and including half-grown nymphs. Later stages were quite resistant, and adult bugs seemed to be only slightly affected.

*Black Scale.* Gesarol A-20 at a dosage of 4 pounds to 100 gallons proved very effective in the control of black scale on gardenias. The immediate effects were very pronounced and the material showed a definite residual action which prevented reinfestation and from a commercial standpoint eliminated the pest.

*Plum Curculio, Codling Moth, and Apple Maggot.* Insectary poison studies at Waltham with a commercial preparation of DDT (Gesarol A-20) used at the rate of  $\frac{1}{4}$ ,  $\frac{1}{2}$ ,  $\frac{3}{4}$ , and 1 pound of DDT per 100 gallons of water showed this material to be surprisingly ineffective against the plum curculio on apples. Further studies on a caged apple tree sprayed with the material corroborated the insectary studies with plum curculio, but indicated promising effectiveness against codling moth and apple maggot flies.

*Flies.* Experiments against adult flies were conducted mainly in the college piggery. On June 21 two pens were sprayed with a solution of 2 gallons of water and 38 cc. of Gesarol SH5, and two pens were sprayed with a solution of 2 gallons of water and 18 grams of Gesarol A-20. An immediate reduction in flies occurred. Dead flies were found on both the treated and the untreated sides. Daily inspections revealed a comparative absence of flies until June 24, when a few were found on the treated side of the piggery during a heavy rain. At the end of a week the flies were present in relatively the same number on both the treated and the untreated sides. Troughs treated with DDT remained free from flies during the experiment.

Experiments against fly larvae in infested manure were conducted. Applications were made on July 19 to 3 pens in the sheep barn. A solution of 1 pint of Gesapon-18 to 10 gallons was employed at rates of 3, 6, and 9 gallons to 27 square yards. In addition 15 square yards of fly-infested soil near the feeders were treated with the material at the rate of 1 gallon of 1 percent solution per square yard. The following day, examination revealed the presence of live larvae in all treatments, both in the sheep barn and at the piggery, indicating that DDT at the concentrations used was not effective. Subsequent examinations bore this out.

**The Value of Control Measures to Supplement the Standard Spray Program for Apple Pests in Massachusetts.** (A. I. Bourne, in cooperation with the Departments of Pomology and Plant Pathology.) The tests in 1944 included studies of the effectiveness in insect control of more accurate timing of applica-



tions, the value of nonarsenical insecticides to supplement the standard schedule, and a study of one form of DDT (Gesarol-20) as an orchard spray material.

All materials were used in combination with wettable sulfur to determine their compatibility and effectiveness in disease control. Special emphasis was laid on the emergency codling moth spray interposed between the 2d and 3d cover sprays and intended to fill the gap existing between mid-June and early July. Records were taken from the McIntosh variety. Fruit from these trees was harvested just before the hurricane of September 14-15. Scab proved to be a minor factor and was well controlled in all plots.

Although in the unsprayed check plot 66 percent of the fruit was more or less scarred by curculio, yet the spray applications timed on temperature ranges were sufficiently accurate to hold the pest in check very satisfactorily except in the plots where DDT replaced lead arsenate. DDT failed to check curculio and 35.6 percent of the fruit in this plot showed curculio damage.

Codling moth proved to be a more difficult problem. Following the standard schedule there was 15 percent injury. One application of fixed nicotine reduced codling moth injury by approximately 2 percent. Two applications of fixed nicotine, however, reduced injury by this species to 5 percent, and a modified schedule employing DX-nicotine in combination with reduced dosage of lead arsenate held codling moth injury to approximately 3 percent. An emergency application interposed between the 2d and 3d cover sprays still further reduced codling moth damage to 1.4 percent.

DDT failed to check plum curculio activity to any marked degree and allowed 10 percent codling moth damage but proved slightly superior to the standard schedule against apple maggot.

The addition of magnesium sulfate to the spray combination, to correct magnesium deficiency, caused no injury to leaves or russetting of fruit and had little or no effect upon the toxicity of the sprays to either insect pests or plant diseases.

A heavy deposit-building dust to protect fruit from late-season stings by codling moth showed definite possibilities. Codling moth damage in dusted plots was only slightly more than half that in adjoining sprayed plots. The dust also held scab successfully.

**Insecticides for the Control of European Corn Borer.** (A. I. Bourne.) A large second brood of European corn borer in 1943, coupled with a mild winter and very little snowfall, produced one of the heaviest carry-overs of larvae in Massachusetts in recent years. Relaxing of clean-up measures left much of the corn standing in the fields, and winter mortality was practically nil. There was every indication of a very heavy infestation for the 1944 season. Hot, dry weather throughout May evidently retarded pupation, which was very slow until the period of one or two light rains about mid-May but proceeded rapidly thereafter. However, during the period of moth activity very unfavorable weather intervened and egg laying was seriously retarded. As a result, throughout practically the entire state, the infestation of early sweet corn was not serious and was very much lighter than anticipated.

DDT spray (Gesarol A-20 at 2 pounds to 100 gallons) and dust (A-3) gave almost perfect control.

Black Leaf 155 at the rate of 2 pounds to 100 gallons was sufficiently effective to indicate that against a light infestation this dosage would give good commercial control if the application was properly timed. Black Leaf 155 at 3 pounds to 100 gallons dosage and derris (4 percent rotenone) spray at 4 pounds to 100 gallons gave better than 97 percent control. As indicated above, the infestation was too light to show any significant difference between treatments. The borer population in the unsprayed checks averaged only 1 to 2 larvae per plant.



**Potato Spraying Experiments.** (A. I. Bourne.) The experimental plots were planted May 9. The young plants appeared within the next 10 to 14 days and averaged 5 to 6 inches in height at the time of the first application on June 12.

During the early season (June and July) the infestation by flea beetles was comparatively light. In late July the number of beetles increased rapidly and continued high until mid-August when the infestation dwindled rapidly and very little scarring of foliage was caused thereafter. There were very few leafhoppers throughout the entire season. Comparatively little damage was caused by European corn borer larvae, and although the potatoes adjoined a plot of field corn the number of second-brood moths hiding during the day in the potato vines was not great. This was in marked contrast to 1943. No late-season damage to potato vines was noted. No serious outbreak of potato aphids occurred. An incipient attack was noted about mid-July and nicotine sulfate was included in the application on July 20. No further steps in control were necessary.

Bordeaux mixture at standard strength of 10-10-100 was applied to the east and middle plots. Calcium arsenate at the rate of 4 pounds to 100 gallons was added to the bordeaux in half of the east plot. DDT (Gesarol A-20) at 2 pounds to 100 was added in one half of the middle plot. Bordeaux at strength of 5-10-100 alone, with calcium arsenate, and with DDT was applied in the west plot. Eleven applications were made at approximately weekly intervals between June 12 and August 28. The new Friend field crop sprayer with a 6-row boom (3 nozzles per row) was used throughout the season and rendered excellent service.

The plants in plots which received the low-copper bordeaux began to ripen and die down in late August and early September. Plants in the plots which received full strength bordeaux for the most part persisted throughout September and many plants were alive and green until they were killed by the frost of October 4-5. The plants suffered considerable damage by the high wind of the hurricane on September 14-15 and from the heavy rain which accompanied it. The injury was aggravated by the period of hot, humid weather which immediately followed the hurricane.

The early ripening of plants in the plots which received the low-copper bordeaux schedule was reflected in the yield, which averaged 320 bushels per acre compared with a yield of 369 bushels per acre in the plots sprayed with standard 10-10-100 bordeaux. The plots in which calcium arsenate and DDT were added to bordeaux (standard strength) yielded approximately 20 bushels per acre more than corresponding plots which received bordeaux alone.

In the series of plots which received standard bordeaux, the addition of calcium arsenate was accompanied by a distinct and immediate reduction of nearly 50 percent in the amount of flea beetle damage. This ratio held through successive weeks. The addition of DDT did not give such noticeable reduction immediately, but showed a cumulative benefit from successive applications which resulted in marked reduction in the number of leaf punctures. Where the low-copper bordeaux alone was applied, practically the same degree of protection against flea beetle was secured as was furnished by standard strength bordeaux. The addition of calcium arsenate or DDT in these plots did not noticeably increase the degree of immediate protection although there was some evidence of beneficial cumulative effects following successive applications.

**Control of Onion Thrips.** (A. I. Bourne.) Application of a dinitro dust (DN-4) gave 97.5 percent reduction in thrips population but caused slight burning of the plants. Lethane (B-71) dust gave 78 percent reduction with no injury. DDT (Gesarol A-3) dust proved only moderately effective with a reduction of 44 percent. Very heavy applications greatly increased the effectiveness of Lethane

and DDT dusts, in both cases giving higher than 88 percent reduction in the number of thrips, which is a very satisfactory control.

Of the sprays applied, nicotine sulfate with Pine Tar soap gave excellent results by providing an effective control of better than 97 percent. Derris powder with the addition of a wetting agent (Ultrawet) ranked very close to nicotine sulfate, causing 95 to 97 percent reduction in thrips population and furnishing very definite residual effects which prevented reinfestation. DDT (Gesarol A-20) spray alone gave 87 percent control, and when used with a wetting agent 91.4 percent control. All of the materials used as sprays proved entirely safe and caused neither immediate burn nor any retardation of growth.

**Biology and Control of the Celery Plant Bug.** (W. D. Whitcomb and Wm. Garland, Waltham.) The celery plant bug (*Lygus campestris* L.) was much less abundant in 1944 than in the two previous years and the infestation in the experimental plantings at Waltham was extremely light. Nevertheless, considerable "blackheart" developed in the early celery, apparently due to a frost on May 19, 1944, followed by abnormally dry weather. Although many plants on which no bugs were observed in semi-weekly observations developed "blackheart", some correlation between "blackheart" and plant bugs was indicated by the presence of 1 (first generation) or 2 (second generation) more bugs per "blackheart" plant than on normal plants. Yellow varieties of celery averaged about 2 more plant bugs per plant than green varieties; and Summer Pascal, the favorite variety in this area, appeared more resistant to plant bug infestation.

With infestations averaging about 20 plant bugs per 100 plants, 2 or 3 applications of insecticides gave excellent protection. Pyrethrum dust containing .2 percent pyrethrins with and without sulfur, and a commercial thiocyanate dust called B-71 gave perfect control after each application, and a .5 percent rotenone dust was satisfactory.

**Naphthalene and Similar Compounds as Greenhouse Fumigants.** (W. D. Whitcomb and Wm. Garland, Waltham.) Experimental fumigations with chlor naphthalene mixtures to recheck a few critical factors in the use of this material were completed.

Preliminary fumigations with alpha bromo naphthalene showed reasonable toxicity to the common red spider but also gave indications of plant injury. However, this material is considered sufficiently promising to warrant further investigation.

**Biology and Control of the Grape Cane Girdler.** (W. D. Whitcomb and Wm. E. Tomlinson, Jr., Waltham.) The grape cane girdler was naturally scarce in 1944, and the time allotted to this project was temporarily transferred to other work.

**Apple Maggot Emergence.** (W. D. Whitcomb.) Apple maggot flies began to emerge in the cages at Waltham in 1944 on June 14, the earliest date since the cages have been in operation. Favorable conditions permitted some of the flies to live until early October and created an unusually long period of activity for this pest.

	Cultivated Soil	Sod
First Fly Emerged	June 14	June 14
25 Percent of Flies Emerged	June 23	June 26
50 Percent of Flies Emerged	July 3	July 3
75 Percent of Flies Emerged	July 14	July 13
Last Fly Emerged	June 26	June 26
Percent of Flies Emerged	66	45

**Control of Plum Curculio in Apples.** (W. D. Whitcomb, Waltham.) Dosage experiments using  $\frac{3}{4}$ , 1, and  $1\frac{1}{4}$  gallons of spray per 100 square feet of surface area of the tree were continued with special emphasis on the effect of this factor in controlling the plum curculio in a heavy crop of apples. During the experiments 246,000 apples were examined. The results indicated that the  $1\frac{1}{4}$  gallon dosage was definitely more effective and that the  $\frac{3}{4}$  gallon dosage was unsatisfactory. The 1-gallon dosage was inconsistent, and suggested that the margin was so slight that the results might be affected by factors which were not measured. The influence of dosage on control of the codling moth was even more significantly in favor of the  $1\frac{1}{4}$  gallon treatment.

Cryolite again proved less satisfactory than lead arsenate against the plum curculio in apples.

During the hot weather in late June and early July many dropped apples infested with plum curculio larvae were burned by the sun. Emergence of larvae from normal apples was 39.4 per 100 fruits; from one-half burned apples, 2.66 per 100 fruits; and from completely burned apples 0.20 per 100 fruits.

**Introduction of Parasites of Oriental Fruit Moth in Peach Orchards.** (A. I. Bourne.) Because of the war emergency it was not possible to conduct the oriental fruit moth parasite-rearing project in 1944.

**Control of Cabbage Maggot.** (W. D. Whitcomb, Waltham.) With normal heavy field infestation by the cabbage maggot, untreated plants of the Early Jersey Wakefield and Charleston Wakefield varieties again showed about 25 percent less injury, and produced 30 to 50 percent more marketable heads than Golden Acre and Super Curled Savoy varieties. Penn State Ballhead also showed considerable resistance.

Tar paper pads and 4 percent calomel-talc dust both gave more than 90 percent control, and corrosive sublimate solution 1-1280 in two applications was satisfactory with 84 percent control. Talc alone gave no protection, and reduced dosages of 2 percent calomel-talc and corrosive sublimate solution 1-2560 in two applications were unsatisfactory against a very heavy attack.

The number of eggs laid on each variety in the period May 6-31 varied from 29 to 14 per plant, with the largest number being found on Charleston Wakefield which showed the least injury, indicating that resistance results from the ability of the plant to resist injury rather than from any repellent action to the flies during oviposition.

**Biology and Control of the Red Spider Mite on Greenhouse Crops.** (W. D. Whitcomb, Wm. E. Tomlinson, Jr., and Wm. Garland, Waltham.) Applications of two forms of DNOCHP containing 20 and 13.3 percent of active ingredient respectively killed approximately 97 percent each of the red spider on greenhouse roses when reduced to equal amounts of DNOCHP by using 8 and 12 ounces respectively in 100 gallons of water. This indicates that a definite concentration of DNOCHP is necessary, whether applied in one heavy application or several light applications. Proprietary sprays containing naphthalene and azo-benzene both gave excellent control of red spider but caused injury to rose foliage.

A proprietary spray containing the extract of yam bean and one containing B-butoxy-b'thiocyanodiethyl ether were both inconsistent and in general gave unsatisfactory control of red spider on greenhouse roses when used according to manufacturer's directions.

**Control of the Squash Vine Borer.** (W. D. Whitcomb, Waltham.) Studies of the susceptibility of different genera of the family Cucurbitaceae to attack by the squash vine borer showed the *Cucurbita maxima* was most heavily infested. The



varieties Blue Hubbard, Warren Turban, and Buttercup squash averaged 3.31 borer injuries per vine. Six varieties of *Cucurbita pepo*, including pumpkin, gourd, and four types of summer squash, averaged 2.23 borer injuries per vine, with the straightneck summer squash the most heavily infested. *Cucurbita moschata*, represented by the Butternut squash, was not infested and appeared to be immune.

*Cucumis sativus*, the cucumber; *C. melo*, the cantaloupe; and *Citrullus vulgaris*, the watermelon, also were not infested.

**New Insect Pests of Importance in 1944.** (W. D. Whitcomb, Waltham.) Outbreaks of the spotted tentiform leaf miner (*Lithocolletis blanchardella* Fab.) occurred in a few orchards in the Nashoba district causing serious injury to apple foliage and accentuating drouth damage. These outbreaks were located in orchards where the infestation was light in 1943. The orchards which were heavily infested in 1943 had little or no infestation in 1944. Six species of parasites were reared from *L. blanchardella*, which apparently explains the absence of the leaf miner following heavy infestations the previous year.

**Spraying Log Piles to Prevent Scolytid Infestation of Elm Logs.** (W. B. Becker.)\* In the spring, between 10 and 21 uninfested elm logs (with bark up to 1 inch thick on xylem up to 11 inches in diameter) were scattered uniformly throughout log piles measuring 4x4x4 feet. Power sprayers were then used to direct various sprays into the piles from the ends of the logs and the top of the pile. At Springfield, a single-nozzle, adjustable-stream spray gun was used at 400 pounds pressure; at Great Barrington, a similar spray gun was used at 100 to 250 pounds pressure; and at Amherst, a six-nozzle spray boom was used with a power sprayer which gave 400 pounds pressure. *The results are based on the number of exit holes per square foot of elm bark found in the logs after late fall.* The figures following each spray mixture indicate the proportion of ingredients and the amount applied per log pile.

	Percent Prevention
At Springfield (practically all the elm scolytids were <i>Scolytus multistriatus</i> )	
Orthodichlorobenzene and No. 2 fuel oil (1-8, 20 gals.)*.....	100.0
Bordeaux and water (1 lb. - 5 gals., 20 gals.).....	61.2
Gesarol SH5 (5% DDT in a summer spray oil) and water (1-100, 20 gals.)....	78.1
At Great Barrington ( <i>Hylurgopinus rufipes</i> was the only or predominant elm scolytid present)	
Gesarol SH5 and water (1-100, 35 gals.) .....	64.3
Orthodichlorobenzene and No. 2 fuel oil (1-8, 8 gals.).....	6.3
No. 2 fuel oil alone (8 gals.) .....	86.0
At Amherst ( <i>H. rufipes</i> was the only elm scolytid present)	
Gesarol SH5 and water (1-100, 14 gals.).....	92.8
Gesarol SH5 and kerosene (1-100, 14 gals.).....	93.6
Orthodichlorobenzene and No. 2 fuel oil (1-8, 16 gals.).....	100.0

\*Approximately 300 cc. per square foot of bark.

**Spraying Log Piles to Kill Elm Scolytids.** (W. B. Becker.) In midsummer, log piles of the same size used for the prevention sprays, but containing logs from which beetles were ready to emerge, were similarly sprayed with the same equipment. *The percentages given are based on the number of exit holes per brood gallery, as compared with the emergence from unsprayed logs.* The figures following each spray mixture indicate the proportion of ingredients and the amount applied per log pile.

\*The author is deeply indebted to Mr. L. Fletcher Prouty, Assistant Superintendent in the Springfield Department of Public Parks, who provided much material assistance in carrying out all the experiments in Springfield.

## Percent Control

At Springfield ( <i>Scolytus multistriatus</i> outnumbered <i>Hylurgopinus rufipes</i> brood galleries by approximately 5 to 4 and 5 to 1 in the various piles)	
Orthodichlorobenzene and No. 2 fuel oil (1-8, 20 gals.)	88.5
Orthodichlorobenzene, D. I. Lestoil, and water (2.5-1-20, 20 gals.)	46.7
Gesarol SH5 (5% DDT in a summer spray oil) and water (1-100, 20 gals.)	9.3
At Great Barrington ( <i>H. rufipes</i> outnumbered <i>S. multistriatus</i> brood galleries by between 10 to 1 and 3 to 1 in the various piles)	
Gesarol SH5 and water (1-100, 20 gals.)	8.6
Orthodichlorobenzene, D. I. Lestoil, and water (3-75-1.5-30, 20 gals.)	59.6
Elgetol, D. I. Lestoil, and water (1-0.5-50, 20 gals.)	74.7
At Amherst (only <i>H. rufipes</i> was present)	
Gesarol SH5 and water (1-100, 15 gals.)	0.0
Orthodichlorobenzene, D. I. Lestoil, and water (1.9-0.8-15.0, 15 gals.)	73.4
Orthodichlorobenzene and No. 2 fuel oil (1-8, 15 gals.)	100.0

### Sprays to Prevent Scolytid Infestation of Individual Elm Logs. (W. B. Becker.)

At Amherst, the following spray mixtures applied to the entire surface of individual elm logs (up to 9 and 17 inches in diameter with bark up to 9/16 and 3/4 inch thick) just prior to beetle flight in the spring gave the indicated percentages of prevention of *Hylurgopinus rufipes* infestation based on the number of exit holes per square foot of bark in the late fall, as compared with unsprayed logs. The figures following each spray mixture indicate the proportion of ingredients and the amount applied per square foot of bark service.

	Percent Prevention
Creosote and kerosene, strained (1-4, 138 cc.; also 1-8, 142 cc.)	100.0
Orthodichlorobenzene and No. 2 fuel oil (1-12, 170 cc.; also 1-8, 113 cc.)	100.0
Gesarol SH5 (5% DDT in summer spray oil) and kerosene (1-200, 141 cc.; also 1-100, 136 cc.)	100.0
Kerosene alone (164 cc.)	100.0
Gesarol SH5 and water (1-100, 169 cc.)	78.4
Gesarol SH5 and water (1-200, 131 cc.)	71.7
Dowax, Gesarol SH5, and water (1184-38-3547, 145 cc.)	50.2
Dowax and water (1-3, 159 cc.)	0.0

At Springfield, the following spray mixtures were applied to the entire bark surface of individual logs (up to 7 and 11 inches in diameter with bark up to 7/16 and 3/4 inch thick at ridges) when scolytids were beginning to attack them in mid-June. The indicated percentages of prevention of scolytid infestation are based on the number of brood galleries which became established per square foot of bark surface, because of the preliminary nature of the experiment. *Scolytus multistriatus* was the only or predominant scolytid in the logs.

	Percent Prevention
Orthodichlorobenzene and No. 2 fuel oil (1-8, 117 cc.; also 1-12, 110 cc.)	98.3
No. 2 fuel oil alone (105 cc.)	97.7
Cuprinol (a commercial preservative used for wood, rope, etc.) alone (98 cc.)	93.0
Creosote and kerosene, strained (1-8, 84 cc.)	92.6
Creosote and kerosene, strained (1-4, 72 cc.)	90.0
Gesarol SHN20 (20% DDT in an oil) and kerosene (1-100, 94 cc.)	79.8
Creosote, D. I. Lestoil, and water (946-757-3785, 99 cc.)	75.4
Kerosene alone (98 cc.)	72.1
Gesarol A20 (20% DDT in a dry spray concentrate) and water (18 gm.-3578 cc., 76 cc.)	59.9
Dowax and water (1-3, 99 cc.)	57.4
Creosote, Aresklene (a commercial emulsifier), and water (946-47-3785, 88 cc.)	52.7
Kerosene alone (19 cc.)	50.6
Ammonium sulfamate (a weed killer) and water (454 gm.-3785 cc., 90 cc.)	48.6
Orthodichlorobenzene, D. I. Lestoil, and water (473-142-3785, 86 cc.)	19.4
Gesarol SH5 and water (1-100, 67 cc.)	12.2
Zinc chloride and water (189 gm.-3785 cc., 128 cc.)	5.4
Gesarol SHN20 and kerosene (1-100, 19 cc.)	0.0

### Sprays to Kill Scolytids Breeding in Individual Elm Logs. (W. B. Becker.)

At Amherst, the following spray mixtures were applied to the entire bark surface of individual elm logs (up to 12 and 21 inches in diameter with bark up to 5/8 and 3/4 inch thick) and gave the indicated percentages of control based on the number of exit holes per brood gallery in the late fall. The figures in parentheses following each spray mixture indicate the proportion of ingredients and the amount applied per square foot of bark surface.

	Percent Control
Orthodichlorobenzene and No. 2 fuel oil (1-8, 135 cc.)	99.9
Creosote and kerosene (1-4, 119 cc.)	97.6
Kerosene alone (113 cc.)	91.1
Orthodichlorobenzene D. I. Lestoil, and water (1-0.3-8, 166 cc.)	80.7

### The Prevention of Elm Scolytid Infestation by Solar Heat. (W. B. Becker.)

At Amherst, freshly cut elm logs lying in a north-south direction in the sun were rolled 180 degrees of their circumference (1) every week and (2) every three weeks during the early season oviposition period (May 18-June 23). After the latter date none were disturbed until after the beetle's active season had ended. Compared with the number of exit holes per square foot of bark in unturned check logs in the sun, 99.7 percent control resulted from weekly turning of logs between 3 and 13 inches in diameter, with bark up to 7/16 inch thick. Turning every three weeks gave 93.5 percent control in logs between 4 and 21 inches in diameter, with bark up to 1/2 inch thick. *Hylurgopinus rufipes* was the only elm scolytid found in the logs.

At Westfield, similar experiments conducted between June 10 and July 15 with logs up to 7 inches in diameter having bark up to 5/8 inch thick gave 100 percent control with both treatments. *H. rufipes* was much more abundant than *Scolytus multistriatus* in the logs.

At both localities the beetle galleries reached a more advanced stage in the logs which were turned every three weeks than in those turned every week. The larger logs usually had more brood galleries than those of small diameter, those less than 5 inches in diameter having none at all even among the unturned check logs.

### Combined Use of Sprays and Solar Heat on Individual Elm Logs to Prevent Elm Scolytid Infestation. (W. B. Becker.)

At Amherst, slightly more than the upper half of freshly cut, uninfested elm logs, 3 to 14 inches in diameter, with bark up to 1 inch thick, and lying in a north-south position in the sun, were sprayed in the spring with creosote and kerosene (strained), 1 to 4 by volume, and then rolled over so the sprayed side was turned down. Compared with unsprayed logs similarly placed, 99.8 percent prevention resulted, based on the number of exit holes found per square foot of bark after the beetle's active season had ended. The only area infested was a small patch of bark on the under side of one log, which was not covered by the spray. *Hylurgopinus rufipes* was the only elm scolytid present.

At Westfield, 100 percent control resulted from similar treatment of elm logs up to 7 inches in diameter, with bark up to 3/8 inch thick. *H. rufipes* was much more abundant than *Scolytus multistriatus* in the control logs.

Some logs less than 10 inches in diameter, which were similarly treated at Amherst on July 2, 1943, and which were left exposed to beetle attack through 1944, did not become infested. However, since unsprayed check logs which lay in the sun did not become infested either, it may be assumed that these logs were too seasoned for scolytid infestation by the spring of 1944.



**Effect of Dry Storage on *Hylurgopinus rufipes* Infestation of Elm Logs.** (W. B. Becker.) At Amherst, winter-cut logs were piled in three dry structures before *H. rufipes* oviposition began in the spring. These structures were two different barns, the large doors of which were often open, and the basement of a building, the small door of which was usually closed. The logs used were about 18 inches long, between 2 and 8 inches in diameter, and had bark up to  $\frac{1}{2}$  inch thick.

Compared with the number of exit holes per square foot in logs piled outdoors in the shade, 96.4 and 99.5 percent control resulted from storing the logs in the barns, and 99.6 percent from storing the logs in the basement. In addition to the possibility of the beetles flying to the logs after they are stored, it must be remembered that *H. rufipes* commonly spends the winter on the trunks of live elm trees and so may be brought indoors on logs cut during that time. The dryness indoors, of course, is unfavorable to the development of those beetles which do become established in the logs.

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## DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

**Breeding Snapdragons for Varietal Improvement and Disease Resistance.** (Harold E. White, Waltham.) The Field Station strains of snapdragons continue to show a high degree of resistance to rust disease in the field and greenhouse. Thirty selections made of resistant lines yielded only seven showing rust, and these showed relatively little rust, being from 10 to 25 percent susceptible. First-generation hybrids of the rust-resistant strains have been much more vigorous than inbred lines. These hybrid types cannot be used for seed production but do give more uniform bloom, flower color, and plant growth. Since at present this type of breeding is practiced on a limited scale with florist's crops, it offers an interesting field of study.

A large flowered, pink snapdragon developed from the Field Station strains was named Helen Tobin, in honor of the wife of the Governor of Massachusetts. Responsibility for distribution of seed of this new variety of winter-flowering snapdragon has been assumed by the Northeastern Regional Unit of the Society of American Florists.

**Disease Resistance and Heredity of Carnations.** (Harold E. White, Waltham.) Carnation seedling plants have been selected from crosses made between disease-resistant and susceptible varieties of carnations. These plants are to be tested for disease resistance, and promising material will be used for further breeding. Pollination work under glass in winter has not given a satisfactory set of seed on many crosses that have been attempted.

**Cultural Treatments of *Anemone coronaria*.** (Harold E. White, Waltham.) *Anemone* tubers soaked 24 hours in warm water, or sprouted in sand in the propagation house, grew much more rapidly than tubers planted dry in the soil. Flower production was greater on treated tubers than on untreated.

Division of the tubers into too small units resulted in decreased flower production. Better flower production and more plant growth were obtained from fertilizer containing nitrogen than from phosphate or potash alone. *Anemones* made excellent growth and flowered as abundantly in gravel as in soil.

**Effect of Fungicidal Hormones on Carnation and Geranium Cuttings.** (Harold E. White, Waltham.) Cuttings of eight varieties of carnations treated with Hormodin Power No. 1 and Stimroot powder showed no difference in degree of

rooting. Cuttings treated with Fermate, used dry and as a liquid solution, showed no differences in rooting response. The Stimroot powder contains Spergon, a fungicide, combined with a rooting hormone; while Fermate is a straight fungicidal material. Since cutting-rot disease was not prevalent in the propagation bench, little can be said as to the respective merits of these materials.

Geranium cuttings were treated with Hormodin powder Nos. 1, 2, 3, Telluric rooting powder No. 66, and Rootone. The Hormodin powders No. 2 and 3 contain more rooting chemicals than No. 1, hence are recommended for use on woody plants more difficult to root. The purpose in using the stronger hormone powders was to determine whether over-abundance of callus tissue, or injury brought about by too much hormone powder, might cause greater losses from rot diseases. The percentages of cuttings lost from rot were as follows: Hormodin 1, 50 percent; Hormodin 2, 47 percent; Hormodin 3, 76 percent; no treatment, 56 percent. Results with the other hormone powders were comparable to those with Hormodin 1. The results of these tests indicate that too much root hormone powder, or a highly concentrated powder, may cause cuttings to be more susceptible to rot diseases.

The treatment of geranium cuttings with copper carbonate and malachite green did not reduce cutting-rot losses in the propagation bed. -

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## DEPARTMENT OF FOOD TECHNOLOGY

F. P. Griffiths in Charge

**The Nutritive Value of Mushrooms.** (W. B. Esselen, Jr., A. Filios, W. H. Fitzpatrick, and E. Weir.) Quantitative data on the amino acid content of mushrooms (*Agaricus campestris*), obtained by microbiological assay methods, showed that they contain approximately 203 mg. of arginine, 458 mg. of isoleucine, 242 mg. of leucine, 144 mg. of methionine, 5 mg. of tryptophane, and 326 mg. of valine per 100 grams on a fresh weight basis.

The total nitrogen content of mushrooms was about 0.5 percent, of which 63 percent was in the form of protein. Purified mushroom protein had a nitrogen content of 11.79 percent. It was concluded that fresh mushrooms contain approximately 2.67 percent of protein. While they are not comparable with such foods as meat and fish as a source of protein, they do compare favorably with some fresh vegetables.

Commercially canned mushrooms (18 different samples) were found to be good sources of the B-vitamins, averaging 0.249 mg. of riboflavin, 1.8 mg. of nicotinic acid, and 0.83 mg. of calcium pantothenate per 100 grams of total can content. The biotin content averaged 6.57 micrograms per 100 grams of can contents.

In the canning of mushrooms, blanching in hot water caused little or no loss of the B-vitamins, but a significant loss occurred during processing. When canned mushrooms were stored for one year, there was some loss of riboflavin but little or no loss of nicotinic acid, calcium pantothenate, and biotin. When fresh mushrooms were cooked by home canning methods, 90.4 percent of the riboflavin, 87.4 percent of the nicotinic acid, 86.4 percent of the calcium pantothenate, and 50 percent of the biotin were retained.

**Glass Container Research.** (W. B. Esselen, Jr., J. E. W. McConnell, J. J. Powers, A. Filios, C. Dubord, and N. Guggenberg.) Added d-iso ascorbic acid did not affect the flavor of asparagus or grape juice canned by commercial methods. The addition of 20 mg. of d-iso ascorbic acid per 100 ml. to bottled grape juice which had been fortified with 50 mg. of l-ascorbic acid per 100 ml.

completely protected the added l-ascorbic acid from oxidation. If bottled grape juice is fortified with ascorbic acid so that it is equal to citrus juice as a source of vitamin C, the ascorbic acid is well retained during storage. Added ascorbic acid is quite stable in apple juice and cranberry juice during processing.

Ascorbic acid has been shown to function as an antioxidant in processed fruits and fruit juices because increased concentrations of it shifted oxidation reactions away from flavor and color substances and more toward the ascorbic acid in accordance with the Law of Mass Action. Redox potential measurements indicate that ascorbic acids also function as antioxidants because they set up low, highly poised potentials in foods. The poisoning capacity of a processed food has been found to be of greater relative importance than its actual redox potential in determining resistance to oxidative deterioration.

Storage at 40°F. in the dark significantly retards the development of rancidity in corn and cottonseed oils. A good quality oil can be stored for one year at room temperature without serious deterioration if protected from the light. Amber glass containers are very effective in protecting edible oils against the effects of diffused daylight. Metal containers protect these oils against the effect of light but a slight off-flavor, due apparently to the container, develops during storage. To date no entirely satisfactory antioxidants have been found which are effective in retarding the development of rancidity in edible liquid oils. Many of those which retard rancidity impart an objectionable off-flavor to the oil. The initial quality of an oil is of major importance in governing its keeping quality.

From an investigation of bacterial load on fresh vegetables it would appear that potential home-canning spoilage bacteria such as spore-forming anaerobes and thermophiles are present in relatively small numbers except in occasional samples, and that their numbers are subject to wide variation. Washing and blanching prior to canning are an effective means of reducing the bacterial content of vegetables. The number of putrefactive anaerobes encountered was very low and may account for the fact that in some sections of the country the boiling water bath method of processing has been used successfully by many people.

In experimental packs of orange juice the addition of small amounts of d-iso ascorbic acid enhanced the retention of the fresh fruit flavor during processing and storage.

During the past two years complaints have been received from home canners that the jar rings they used imparted an off-flavor to home-canned foods. This problem has been investigated in cooperation with the War Food Administration and the jar ring industry. Two promising test methods have been developed by which it is possible to determine the tendency of jar rings, made from different types of rubber and other constituents, to impart off-flavors to foods. These methods have been of value in ascertaining the source of off-flavors in jar rings, and may also be of value in maintaining quality control in their manufacture.

Fifteen different varieties of peaches, provided by the Pomology Department, were canned according to home-canning techniques. The canned products were evaluated as to quality after storage for six months. Ideal, Valiant, and Ambergem varieties were graded as very good; Red Rose, Champion, New Jersey 116, Golden East, Golden Glow, Golden Globe, Hale Haven, Summer Crest, and Vedette as good; and New Jersey 66, Delicious, and Radiance, as fair.

Tests were also conducted to determine the effect of different processing methods on the quality of home-canned peaches. The boiling water bath method and processing at 0 to 1 pound steam pressure in a pressure canner gave the best product. Processing at 5 or 10 pounds steam pressure for a short time in a pressure canner resulted in a product inferior to that obtained by the former methods.



The color of home-canned beets was influenced by the variety of the beet used. It is recommended that, for a home-canned product of good red color, the Detroit Red or Detroit Dark Red variety be used.

In controlled processing studies with green beans those processed in a pressure canner were superior in color, flavor, and texture to similar beans processed in a boiling water bath.

**Home Freezing — Fruit and Vegetable Variety Studies.** (W. B. Esselen, Jr., J. J. Powers, K. Lawler, F. P. Griffiths, and J. E. W. McConnell.) Through the cooperation of the Olericulture and Pomology Departments tests were made to study the suitability of different varieties of Massachusetts-grown peaches and vegetables for home freezing. The products were frozen by accepted techniques and after storage for six months were judged for quality by a tasting panel, on a basis of flavor, texture, and color. Of 15 varieties of peaches Vedette, Valiant, Golden Globe, Red Rose, Ideal, Radiance, and New Jersey 116 were considered very good; Hale Haven, New Jersey 66, Ambergem, Summer Crest, Golden East, Champion, Golden Glow, and Delicious were considered good. On a basis of flavor, Summer Crest, Vedette, and Ideal were preferred.

Seven varieties of green peppers (King of the North, California Wonder, World Beater, Harris Early Grand, Harris Wonder, Waltham Beauty, and Charter Oak) were frozen, both raw and blanched. All varieties yielded a satisfactory frozen product.

Eight varieties of sweet corn were frozen, both on the cob and as whole-kernel corn. When frozen on the cob Seneca Dawn, Span Cross, Early Golden, and Golden Cross Bantam were very good; North Star, Narcross, Sugar and Gold, and Seneca 60 were considered good. In general the cut whole-kernel corn yielded a better product than that frozen on the cob. When cut off the cob in the whole kernel form Early Golden was considered to be excellent; Seneca Dawn, Span Cross, North Star, Golden Cross Bantam, and Narcross were graded very good; and Sugar and Gold and Seneca 60 were considered good.

Twenty different strains and varieties of carrots as represented by Morse's Bunching, Chantenay, Nantes, Long Change, Oxheart, Hutchinson, Danvers Half Long, and Imperator were all satisfactory when frozen.

Tests with summer squash indicated that this vegetable when frozen had only a fair flavor and would not be acceptable to many people.

**Fishery By-Products.** (F. P. Griffiths.) It was found that the common female sculpin or blow fish could be well utilized as a source of eggs for caviar. Caviar so prepared was very tasty and of excellent quality. About 10 percent of the weight of the fish is roe. The tail portion of the fish may be skinned and makes a very edible food. By utilizing both the roe and the tail, the sculpin should have commercial possibilities.

**Venting Community Cannery-Type Retorts.** (W. H. Fitzpatrick, J. E. W. McConnell, and W. B. Esselen, Jr.) (Cooperative project with the School Lunch and Distribution Branch of the Office of Supply (CCC), W.F.A.) The so-called No. 2 and No. 3 size retorts used in community canneries are intermediate in size between the pressure canners used in home canning and the large retorts used in commercial canneries. Studies were carried out to determine proper venting procedures for No. 2 and No. 3 retorts. Over 200 venting and heat distribution tests were made on No. 2 size self-heating and steam retorts and a No. 3 size steam retort. The effect of different retort loads of cans and jars on venting requirements was also studied. On a basis of the data obtained, recommendations for venting community cannery retorts have been made to the War Food Administration.

**Red Squill Research.** (L. R. Parkinson and F. P. Griffiths.) Laboratory tests have confirmed the fact that red squill (a raticide) of low toxicity may be fortified with a concentrate containing the toxic principle of red squill in order to provide a satisfactory commercial product. Such red squill preparations should prove to be very effective for rodent control.

**Vitamin D Milk Investigations.** (L. R. Parkinson and F. P. Griffiths.) Studies have been continued on the fortification of fluid milk with vitamin D. During the past year 173 samples have been assayed and all but five contained the designated amount of vitamin D. Data obtained during the past three years indicate that the present methods of fortification are reliable and that the producers of vitamin D milk are making every effort to provide a standardized product.

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## DEPARTMENT OF HOME ECONOMICS NUTRITION

Julia O. Holmes in Charge

**A study of Methods for Determination of Riboflavin.** (A. W. Wertz, B. V. McKey, K. O. Esselen, and J. O. Holmes.) In a fluorophotometric assay of the riboflavin content of foods, conducted last year, it was discovered that the recommended procedures were not entirely satisfactory with highly pigmented foods such as kale and baked beans. A comparison was therefore made of the biological, microbiological, and fluorophotometric methods currently used in assays for this vitamin. Four foods were studied: beans, milk, kale, and fish. Good agreement between certain modifications of these three methods was found when applied to milk, kale, and mackerel. The microbiological method appeared to give low values for baked beans.

On the basis of the good agreement between the three types of assay procedures, it was concluded that one currently recommended step in the fluorophotometric procedure was responsible for the introduction of a marked error in assay values; namely, the manner in which the comparison was made between the fluorescence of the food extracts and the standardized solution of riboflavin. In every instance in which the fluorescence of the standard was determined apart from the food extract, erroneously low values were obtained; in those instances in which the riboflavin standard was added to the extract, values were obtained which agreed well with those obtained by the biological method and, with the exception of those for beans, with the microbiological method. The conclusion therefore has been drawn that it is imperative that the standardized solution of riboflavin be added to the food extract.

Both the fluorophotometric and the microbiological procedures contained manipulations found to be unnecessary when applied to the foods studied. The enzymatic digestion of the foods appeared to be unnecessary. In the microbiological procedure, the removal of fat from the extracts and the addition of an irradiated extract to the blank and to the standard curve did not affect the values for riboflavin. In the fluorophotometric method the use of florasil on which to absorb the riboflavin conferred no advantages. This was true also for the procedure involving the oxidation of the extracts with  $\text{KMnO}_4$ .

The riboflavin content of frozen baked beans, blanched kale, and steamed fish did not decrease over a six-month period.

**Relationship Between Calcification of Eggshell and Carbonic Anhydrase Activity.** (Marie S. Gutowska and U. C. Pozzani.) Previous study in this laboratory has shown a direct relationship between the activity of carbonic anhydrase in the shell gland of the hen and the calcification of the eggshell. The administra-

tion of sulfanilamide, a strong inhibitor of this enzyme, resulted in an inhibition of eggshell calcification. The present report presents a study of the effect of inhibitors other than sulfanilamide on the action of carbonic anhydrase on eggshell calcification; namely  $\text{NaCNS}$ ,  $\text{KMnO}_4$ , and  $\text{MnSO}_4$ .

Rhode Island Reds of known laying capacity were held in confined laying batteries. The chemicals were administered either subcutaneously or orally. Meldrum and Roughton's manometric method was used for determining carbonic anhydrase activity in the blood and the shell gland. The quality of the eggshell calcification was determined by the eggshell breaking strength.

The administration of  $\text{NaCNS}$  was followed by (a) an inhibition in carbonic anhydrase activity of both blood and eggshell gland, and (b) a lowering in quality of the eggshell. These changes were similar to those observed following sulfanilamide administration. In contrast,  $\text{KMnO}_4$ , although a good in-vitro inhibitor of carbonic anhydrase, had little effect when administered to hens. The administration of  $\text{MnSO}_4$ , either orally or subcutaneously, was followed by an increase in the carbonic anhydrase activity. Finally, a direct relationship was found between carbonic anhydrase activity and well-known seasonal variations in breaking strength of the eggshell.

These studies provide further evidence that the formation of the eggshell is controlled by carbonic anhydrase. It is suggested that this enzyme acts as a catalyst in the shell gland for the decomposition of carbonic acid, thus allowing a greater number of carbonate ions to be released. These carbonate ions unite with calcium and are then precipitated as calcium carbonate, thus forming the eggshell.

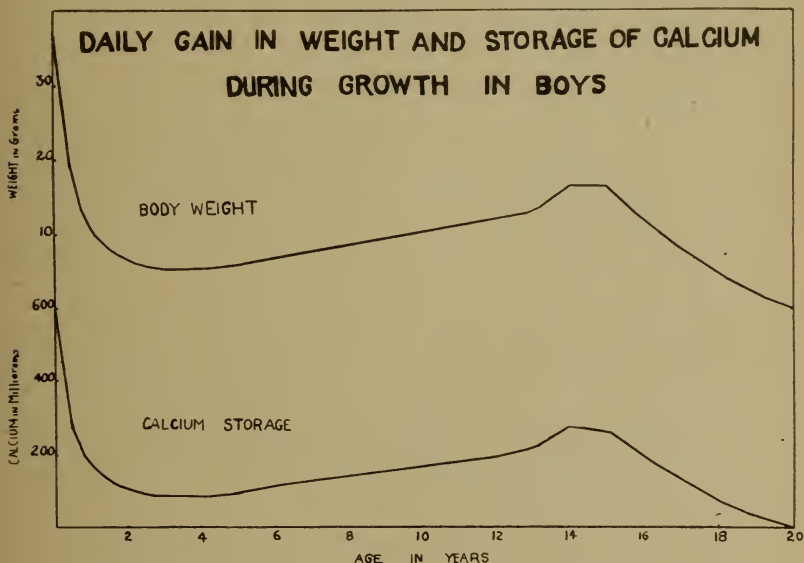
**The Requirement for Calcium During Growth.** (Julia O. Holmes.) Since nutrition literature carries conflicting statements concerning the calcium requirement of children, an attempt has been made to clarify the problem. No data could be found concerning the rate at which calcium is deposited in the human body during growth. Neither could reliable information be found concerning the weight of the skeleton at different ages, an important consideration since 99 percent of the total body calcium is located in the skeleton. A search was therefore made for such information for farm and laboratory animals. Suitable data were found only for Shropshire sheep and albino rats, and included gains in weight of the body and of the skeleton, and increases in calcium content of the body at different ages. When the gains for various intervals during the growth period were expressed as percentages of the total gains made between birth and the attainment of maturity, the percentage gains in calcium were identical with the percentage gains in weight.

Since this relationship between percentage gains in calcium and in body weight was found in two strictly dissimilar types of animals, the assumption was made that the same relationship would occur in all species, including man. If this assumption is valid, it follows, for example, that the child who has accomplished 11 percent of his total growth at the end of the first year has also stored 11 percent of his total calcium. On this basis, the approximate daily storage of calcium which might be expected in boys reared under satisfactory dietary conditions was calculated and is shown in the accompanying chart, together with their daily gains in weight. The storage of calcium by girls is not significantly different during the early years of life. Their pubertal spurt of growth, however, starts earlier than in boys, i.e., at 11 or 12 years of age; and the entire process of growth is accomplished earlier than in boys, probably by the 17th year.

In converting these values for calcium storage into terms of dietary calcium, it must be recognized that infants utilize only about 35 percent of the calcium they eat; preschool children, 20 percent; and older children, 25 percent. The



following conclusions can be drawn: (a) during the first six months of life, infants need more calcium than they receive under current dietary practices; (b) the child between two and five years of age would have his calcium needs satisfied by approximately one cupful of milk in addition to an otherwise adequate diet and (c) at the peak of the pubertal spurt the child would need approximately three cupfuls of milk daily. Children previously undernourished in respect to calcium would need somewhat more calcium to bring their bones to a stage of physiological calcification.



## DEPARTMENT OF HORTICULTURE

R. A. Van Meter in Charge

**Factors Influencing the Hardiness of Evergreens.** (C. J. Gilgut, Waltham.) The winter of 1944-45 was one in which there should have been little or no winter injury to ornamental woody plants. There was abundant rain in the fall, there was plenty of snow on the ground, and the temperature did not go excessively low. Yet there was as much winter injury as in the winter of 1943-44 which was preceded by an unusually dry summer and fall and during which there was almost no snow—conditions commonly stated as the cause of winter injury.

Although varying with individual plants, the injury in 1944-45, as in 1943-44, was no more extensive on plants grown with fertilizers to produce an abundant soft growth late in the season than on plants grown without fertilizer to produce a moderate amount of growth with ample opportunity for it to harden before winter.

That winter injury is not avoided when plants are grown slowly without fertilizers is shown well in a block of 128 arbor vitae (*Thuja occidentalis globosa*) set out 5 years ago. The plants received no other treatment than regular cultivation to control weeds, and the amount of current seasonal growth was moderate. They

experienced a wet previous summer and fall, a dry previous summer and fall, a winter with almost no snow, a winter with plenty of snow, mild winter temperatures, and severe cold winter temperatures. Records of the winter injury on each plant were made each spring, and it was found that there was no correlation between slow growth and winter injury. Each plant has shown injury at least once, and some have shown it after each winter. In all cases injury appeared in the spring, usually in April and two or more weeks after prolonged strong winds.

To determine whether wax sprays would prevent winter injury, several plants of *Globe arbor vitae* were sprayed late in the fall with Dowax 1 part to 4 parts of water. None of the plants showed winter injury, although all plants had been injured in previous winters.

**Study of Herbaceous Perennial Material.** (C. J. Gilgut, Waltham.) In the study of cultural requirements and winter hardiness of herbaceous perennial plants, no mulch was used during the winter. There was a good cover of snow and perhaps for this reason fewer plants were lost from winterkilling than during the previous winter when there was no snow and a hay mulch was put on after the ground froze.

Bearded iris when divided and transplanted about one month after flowering suffered less seriously from winter injury and produced better flowers the following year than when transplanted later in the season.

Professional gardeners, landscape men, nurserymen, and the general public continue to visit the gardens regularly to become better acquainted with the newer and better garden plants. Of the thirty-six new acquisitions placed in the gardens for test, many have not been introduced or disseminated to the gardening public. Numerous requests, by visitors and through the mail, for information on varieties, cultural requirements, fertilizers, and suppression of insect pests and fungous troubles were answered during the season.

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## DEPARTMENT OF OLERICULTURE

G. B. Snyder in Charge

**Weed Control in Fields of Carrots and Parsnips.** (W. H. Lachman.) It has recently been found that certain oils sprayed on fields of carrots and parsnips would destroy weeds without harming these crops. Rather extensive experiments at the college as well as many cooperative tests by vegetable growers throughout the State have indicated the value of this method for controlling weeds.

Oils which, in general, pass the specifications for "Stoddard Solvent" have given good weed control with no deleterious results. Some of the materials which pass these specifications are: Mineral Spirits, Naphtha No. 52, Sovasol No. 5, Stoddard Solvent, Sun Spirits and Varsol No. 2. Another oil, Sovasol No. 75, was found to be a good selective weed killer when mixed with two parts of white kerosene. These oils are used in industry as paint thinners, for dry-cleaning clothes, and as solvents. They seem to be highly selective for members of the Umbelliferae family such as carrots, parsnips, celery, and parsley. The leaves of celery and parsley, however, seem to be more sensitive and under some conditions are severely burned by these oils. The sprays completely destroyed young beet and turnip plants.

Best results were obtained if the oil was applied when the weeds were small and succulent. On a clear, warm day the weeds were often wilted within a half hour after spraying and were dead the next day. Almost all of the common weeds encountered have been completely controlled, with the exception of ragweed,

which is particularly resistant to the effects of the oil. Some of the carrot leaves developed a lighter color after spraying, but this disappeared in about a week with no other noticeable effect on the plants. There was no indication of a toxic residue in the soil when these oils were applied at the rate of 80 to 120 gallons per acre, which effected good weed control. The oil costs \$.15 to \$.20 per gallon, depending on the locality, so that on the average the material to spray an acre costs about \$20.00. At the present wage scales it costs approximately \$40.00 to hand weed an acre of carrots.

It is desirable to apply the oil as a flat, fan-shaped spray since this gives much more uniform distribution than a cone spray. The Skinner greenhouse irrigation nozzle ST50 was found to be well adapted to delivering the desired type spray. The oil seemed to give best results when applied at about 100 pounds pressure. Higher pressures developed a drifting mist type of spray that was objectionable.

It is suggested that this method of weed control be tried on a small scale at first much the same as with other new developments.

Other details of this method have been published in Massachusetts State College Extension Special Circular 120, and a report also appears in the Proceedings of the American Society for Horticultural Science, Vol. 45.

**The Carotene Content of Carrots.** (W. H. Lachman.) Ten varieties and strains of carrots were grown during 1944 and were analyzed for carotene during successive stages of maturity as well as after storage in a warm room for three weeks and in cold storage at 32°F. for five months. From the results of the analyses it was rather apparent that the carotene content of carrots increased as the root matured. Carotene appeared to be directly correlated with a deep orange coloration in both the core and cortex of the carrot. Expressed as thousands of Vitamin A Rat Units per pound, the carotene content of the mature carrots ranged from 51.5 to 98.0; from 76.0 to 156.0 after 3 weeks at room temperature; and from 56.5 to 100.0 after 5 months at 32°F. It is noteworthy that the carotene in the carrots was relatively indestructible under various storage conditions, even showing an apparent increase which was no doubt due to moisture loss through respiration and evaporation.

Two bunches of California-grown Long Imperator carrots, purchased on the open market early in April, 1945, were found to have a carotene content of 62.0 thousand Vitamin A Rat Units per pound. These were bunch carrots and rather small. A similar sample, purchased in early May, 1944, analyzed 98.0 thousand units. These carrots were a little larger, which probably accounts for the greater carotene content.

**Vegetable Breeding.** (W. H. Lachman.) A large number of sweet corn inbreds has been produced by inbreeding open-pollinated varieties. One of the most promising of these, Massachusetts No. 8, is being increased for production by a large seed grower in Idaho. Massachusetts 8 is an excellent inbred line. It has many of the characteristics of Purdue 39 but is about a week earlier, has a larger ear, stiffer stalk, and excellent seed quality.

Number A-13 tomato, a selection from the cross Allred by Rutgers has been sent out for trial in several states and has performed very well in Maine. It has good color and yields well over a long season, but the fruit has a tendency to be soft. This tomato has been back-crossed to Rutgers in an effort to recover more size and solidity.

A number of sweet pepper selections have been made which have excellent type and are particularly resistant to tobacco mosaic. Further testing is necessary to evaluate these selections.



**Asparagus Investigations.** (Robert E. Young, Waltham.) In a breeding project which has as its objective the improvement of asparagus both as to yield and uniformity, individual plant performance was recorded for 450 plants, representing five selected lines and one commercial strain. As evidence that increases in yield can be obtained by selection, the two highest producing strains in 1944, Nos. 1 and 4, each produced 1.3 pounds of asparagus per plant, compared with 0.76 pound per plant from Mary Washington grown from the best commercial seed. These averages are based on plots containing 75 to 98 plants each. The five-year average for these three plots in pounds of asparagus produced per plant is: No. 1, 1.18; No. 4, 1.22; and Mary Washington, 0.62.

There is a variation from year to year in the average number of spears the plants produced and also in the weight. This appears to be of a biennial nature, being up one year and down the next. Whether there is a correlation between the variation in yield and the weather cannot be accurately determined until the yield records for a greater number of years are available.

There is considerable variation in the production of individual plants in all of the strains. The plants were divided into four groups on the basis of the number of spears produced in 1944: A, 1 to 10 spears; B, 11 to 20; C, 21 to 30; and D, 31 and up. Strain 1 had almost equal distribution of plants in each group; Strain 4 had 9 percent in A, 38 percent in D, and the rest divided equally between B and C; while Mary Washington had 46 percent in the low-producing group A, 32 percent in B, 12 percent in C, and only 10 percent in the high-producing group D. Selection of parent plants on the basis of yield has, in this second generation, greatly reduced the number of plants which produced only a few stalks, and approximately doubled the yield.

For the second consecutive year, there was no rust. There was very little rust from 1937 through 1940, a moderate infection in 1941, and a severe outbreak of the disease in 1942, followed by these last two years when there was none. Weather appears to be the determining factor.

**Vegetable Breeding for Improvement of Quality.** (Robert E. Young, Waltham.) During the year breeding work has been conducted with broccoli, greenhouse cucumber, celery, rutabaga, New York type lettuce, tomato, carrot, and Butter-nut squash. While progress has been made in the development of strains of broccoli, carrot, and celery better adapted for local use, it is insufficient to justify detailed discussion.

**Trellis Tomato.** While Trellis No. 22 and Waltham Forcing tomatoes bred at the Waltham Field Station have wide usage as trellis tomatoes, both are somewhat inferior in table quality. With the desire to retain the cultural and market characteristics of Trellis No. 22 but to improve table quality, crosses were made several years ago with Marglobe, Rutgers, Michigan State Forcing, and Baltimore. Several selections from these crosses, now in the fifth and sixth generation were tested for yield and market adaptability. Earliness is one of the important characters of a good trellis tomato. Two selections, one a cross between Early Trellis and Marglobe, and the other a cross between Early Rutgers and Early Trellis, produced more early fruit than Trellis No. 22, as well as a greater total yield. Trellis No. 22 had a yield of 10.5 pounds per plant; the Marglobe cross 11.0; and the Early Rutgers cross 11.7 pounds. There was no significant difference between the three strains in percentage of No. 1 fruits or in percentage of cracked fruits. Although it has not been possible to keep all the table quality of Rutgers and Marglobe in the two selections, they are an improvement over Trellis No. 22. If the increase in yield is maintained for another year, samples of seed of these selections will be distributed to growers for further testing.

During the harvest season it was noted that one selection, a cross between Trellis No. 22 and Baltimore, did not crack. During the early part of the picking season it had only 1.8 percent cracked fruits as compared to 33 percent for Trellis No. 22. (In this case, a crack is regarded as any split in the skin regardless of size.) The crackless fruit was found to have air pockets surrounding the seed cavity which may offer some explanation as to why cracking does or does not occur.

*Greenhouse Cucumber.* Seed of two hybrid cucumbers that were reported last year as out-yielding their parent lines 25 percent was distributed to growers for trial, along with two of the inbred lines. Either the hybrids or the strains, or both, were tried in about twenty-five different greenhouses.

Hybrid No. 11 was considered the best by the largest number of growers. Hybrid No. 10 and strain No. 1 produced well for some. Strain No. 2 was too short to be a satisfactory greenhouse cucumber. One grower who kept very accurate records reported that hybrid No. 11 produced 18 percent more cucumbers during the month of March than his own strain.

The problem of producing hybrid cucumber seed for the growers is under consideration, and experiments are being conducted.

Samples of seed of hybrids No. 10 and 11 and strain No. 1 are available to greenhouse growers for further trial and testing.

*Rutabaga or Cape Turnip.* Bristol White rutabaga, bred for the growers in Bristol County, Massachusetts, has been found by growers in other sections of the country to have wide adaptation. It produced a satisfactory crop in dry weather when other varieties produced woody, inedible roots. Further testing of this variety has been delayed by a seed crop failure resulting from a mosaic disease. However, samples will be available for distribution in 1946.

There has been very little opportunity to have Waltham Yellow rutabaga tested because of the failure of the seed crop.

The characteristics of both of these varieties were given in last year's Annual Report.

*New York Type Lettuce* (In Cooperation with U. S. Bureau of Plant Industry). The name Waltham Imperial has been given to a selection taken from material supplied by the cooperating agency. This selection is somewhat similar to Great Lakes and was taken from the same breeding material. Two years' trials indicate that under local conditions Waltham Imperial will produce a greater percentage of marketable heads than Great Lakes. In the 1944 spring trials, this strain produced 97 percent marketable heads as compared to 81 percent for Great Lakes.

Since lettuce is so greatly influenced by weather conditions, it is necessary to make tests and comparisons for several years to determine whether the strain is sufficiently broad in its adaptability to produce marketable heads each year regardless of the weather. As soon as a supply of seed can be produced, samples will be distributed to growers for trial.

Other strains and selections were tested and some seemed to be well adapted for summer use. One strain, No. 13, produced 92 percent marketable heads as compared to 46 percent for Waltham Imperial and 45 percent for Great Lakes.

*Greenhouse Lettuce.* Trials of Waltham Early Forcing lettuce in growers' greenhouses indicate that it is not so good as Bel-May. Some of its characteristics were improvements but others more than offset them. Breeding work with greenhouse lettuce is being discontinued except to maintain a supply of stock seed of the Bel-May.

*Butternut Squash.* The Butternut squash has become popular on the Boston market during the past few years. The origin of this squash is somewhat obscure. Seed production has been in the hands of local growers. There has been a marked lack of uniformity in this squash, and an increasing desire on the part of growers for a better and more uniform strain. To determine whether any of the strains now in use are superior to others, 18 different strains were secured from both seedsmen and growers for trial. The yield varied from 269 to 562 boxes per acre, the percentage of cracked fruit from 10 to 31, and the percentage of crooked fruit from 1 to 37. Crooked fruits are very objectionable because they are difficult to pack in the bushel box which is the market package for this squash.

Almost all of the strains contained at least one good characteristic but none seemed to combine them all. Breeding work has been started to produce a true high-yielding Butternut squash.

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## DEPARTMENT OF POMOLOGY

R. A. Van Meter in Charge

**The Influence of Various Clonal Rootstocks on Apple Varieties.** (J. K. Shaw and L. Southwick.) The hurricane of September, 1944, caused damage to the trees on the dwarfing rootstocks. Those on Malling IV and IX suffered most. Those on Malling V and on the standard and near standard stocks showed no injury.

Some trees broke off at the point of union between stock and scion, a few broke below the union, and some were tipped, varying from little to complete prostration. The proportion of trees ruined was small, but large enough with some stock-scion combinations to make the use of them doubtful. We had considered Malling IV to be one of the best semi-dwarfing rootstocks, but this experience suggests its greatest weakness. Most varieties on this rootstock grow rapidly and bear early in life, but they have poor anchorage. Trees on Malling IX are usually poorly anchored and the stock, though large in diameter, is brittle so that the trees tip or the rootstock breaks when subjected to severe winds. It is a good rootstock for the home garden, making low-headed trees which bear at the age of two to four years. Home garden trees are usually located where they have some protection from high winds, and some support such as stakes made from used iron pipe is easily provided.

This experience should not discourage the use of semi-dwarf apple trees, but such orchards should not be planted on poor soils or on wind-swept sites. They should be headed low and pruned rather more severely than standard trees in order to keep them low headed. Perhaps they should be budded 8 or 10 inches high so that they can be planted deeper in the orchard. In this experimental orchard, all the trees were treated alike for purposes of comparison.

The crops of both 1944 and 1945 were much reduced by spring frosts. The amount of bloom is the best indication of potential early production of trees on dwarfing and semi-dwarfing rootstocks. It is evident that the usual habits of varieties appear when they are grown on these stocks but with some modification. Trees on Malling VIII and IX may be expected to bear at the age of two years for Golden Delicious, and four or five years for Northern Spy. Production of some naturally early-bearing varieties as Oldenburg and Wagener seems to be hastened less than that of Golden Delicious. Trees on the semi-dwarfing stocks seem to begin to bear from two to four years earlier, according to variety, than trees growing on seedling stocks.



**Lethal Incompatibilities Between Clonal Stocks and Varieties of Apples.** (J. K. Shaw and L. Southwick.) The varieties and strains growing on the clonal stocks Spy 227 are now in their third year from the bud. Only three varieties of common apples are growing normally. They are Shotwell Delicious, Paragon (Iowa strain), and strain G of McIntosh. Yates, "Paragon L", and McIntosh strain 12 are alive but making little or no new growth. Golden Delicious trees are nearly all dead, but a few have weak shoots from the base of the tree. Those now completely dead are Delicious, Starking, Richared, Stayman, Stamared, Blaxtayan, Winesap, Arkansas Black, Arkansas, Mammoth Black Twig (Iowa Strain) Turley, Blackmack, and McIntosh strains 1, 8, 39, 45, and R. The ornamental crabs, *Malus atrosanguinea*, *floribunda*, *hupehensis*, *sargentii*, *toringoides*, and Bechtel crab are all growing normally. McIntosh R, Stayman, and Winesap, which failed when budded on Spy 227, are still growing vigorously on the two clonally propagated rootstocks Spy 227-2 and Spy 227-12 which came from seedlings of Spy 227. Further studies planned to throw light on the nature of this lethal incompatibility are being carried on. A second paper reporting on this project appears in Volume 45 of the Proceedings of the American Society for Horticultural Science.

**Study of the Bud Sports of the McIntosh Apple.** (J. K. Shaw and L. Southwick.) None of the strains reputed to be distinctly striped have yet fruited. Several strains reputed to be uniformly red have fruited, also one random selection considered to be an ordinary McIntosh. This seems to be slightly inferior in color to the strains selected for high color. Those fruiting are growing on very dwarfing stocks while none of the striped strains are on very dwarfing stocks. Spring frosts in 1944 and 1945 have interfered with cropping in this orchard. Further observations are needed before any positive evaluation of these red strains can be made. Doubtless the distinctly striped strains should be avoided.

The orchard of seven strains on three clonal stocks, now in its fourth year of growth, shows no significant differences in vigor of these strains. The present differences in size of the trees seem to be due to environmental conditions and the size of the trees when set.

**The Genetic Composition of Peaches.** (J. S. Bailey and A. P. French.) Since there was a crop in 1944, further data were collected on two lots of seedling peaches and three were selected as worthy of further trial.

In the spring of 1945, some seedlings from the northern Caucasus region, reported to be very hardy in bud, were set in an orchard to compare their hardiness with that of Elberta and Greensboro.

**Tree Characters of Fruit Varieties.** (J. K. Shaw, A. P. French, O. C. Roberts, and L. Southwick.) This project has been under way for many years and the basis for identifying practically all varieties of apple, pear, plum, and cherry, originating as seedlings, has been established. The apple variety Van Buren, believed to be a bud sport of Oldenburg, is the only variety of such origin that can be distinguished from its parent. The constant appearance of new varieties makes the continuance of this work desirable. Some progress with peaches has been made, but it is doubtful whether it is possible to distinguish some varieties in the nursery. However, most of the nursery mixtures can be detected and many thousands of misnamed peach trees have been eliminated from the trade.

The practice of examining nurseries for trueness-to-name enters its 25th year in 1945. This work is now carried on by members of the College staff under the name of the Massachusetts Trueness-to-Name Inspection Service, sponsored by the Massachusetts Fruit Growers' Association.

A bulletin on pear varieties has been published.

**Nature of Winter Hardiness in the Raspberry.** (J. S. Bailey, A. P. French, and R. A. Van Meter.) Five canes each of the varieties Marcy, Washington, Taylor, Milton, Chief, and Latham were brought into the greenhouse at about weekly intervals from November 7 to December 21, 1944, for forcing.

Among the canes brought in November 7, those of the varieties Marcy, Washington, and Milton started in 37 to 39 days, while some of the canes of the varieties Latham, Chief, and Taylor never did start. By November 15 all varieties could be forced to grow, but the first three varieties started more readily than the others. By December 1, all varieties except Chief started on the average in from 17 to 22 days. Therefore, (1) these varieties are divided into two groups, one of which can be started into growth more readily than the other; and (2) for all but Chief the rest period was over by December 1 and for Chief by December 21.

A Wheatstone bridge apparatus was set up to test the resistance of raspberry canes in the hope of finding a method to tell in the field whether canes are alive or dead. When live canes were tested and then killed by freezing in a cold room, the resistance was less after freezing. As canes dried out the resistance increased. Canes brought in from the field during the winter and tested had either a normal or a very high resistance. The latter indicates that the canes had either been killed by drying or had dried out between the time they were killed and the time the resistance tests were made.

**Controlled-Atmosphere Storage of Apples.** (L. Southwick and O. C. Roberts, in cooperation with the Department of Engineering.) The 300-bushel controlled-atmosphere room was filled on September 28, 1944, and opened on March 7, 1945. Instead of maintaining the levels of oxygen and carbon dioxide at 2 and 5 percent respectively, necessitating the use of a special air scrubbing apparatus, it was decided to try the English system of 10 and 11 percent, which can be maintained in a tight room by the proper use of ventilation. Actually the carbon dioxide level ranged mostly between 9 and 11 percent. The sum of the carbon dioxide and oxygen always equalled about 21 percent which is the percentage of oxygen in air. The temperature was maintained at 40°F.

The main test was with McIntosh from 25 individual trees. Check lots were stored in the usual way around 32°F. Average firmness of the flesh as measured by a pressure tester on March 6 showed no consistent differences, indicating that the levels of oxygen and carbon dioxide used were not so effective in prolonging storage life of McIntosh apples as the levels previously used; namely, 2 and 5 percent. Furthermore, scald was a real factor varying from very light to very severe, and averaging about 10 percent. Apples from some trees showed from 50 to 75 percent visible scald on removal from the controlled-atmosphere room. This was probably due to the relatively high carbon dioxide concentration. Only occasional scald was found on McIntosh in the regular storage.

Cortland apples from two orchards softened significantly less in the controlled-atmosphere room than in regular cold storage, but scald was much worse.

The possibility of positive scald control by air purification is under study.

**Comparison of Cultivation and Sod in a Bearing Orchard.** (J. K. Shaw.) This experiment has now a continuous record for 24 years. Certain changes of treatment of some of the seven 10-tree plots of McIntosh apple trees have been made from time to time. In addition to the comparison between sod-nitrogen and cultivation without fertilizer, the effect of hay mulch and of the addition of phosphorus and potash to nitrogen have been studied.

The sod vs. cultivation question was soon answered. Cultivation without nitrogen does not maintain production. This conclusion has been supported by

practical experience. No successful Massachusetts fruit grower now attempts to grow apples without nitrogenous fertilizers.

The application of a hay mulch with no other fertilizer to one of the cultivation plots more than doubled the yield over a six-year period. This practice is increasing in Massachusetts orchards.

The application of nitrate of soda only to a cultivation plot quickly increased yields, but they have not been well maintained.

The answer to the question of the value of phosphorus and potash added to nitrogen is not so clear. There is some indication that when applied to grass sod, yields are maintained better. We dare not say that it has been profitable.

The problem of orchard fertilization is a complicated one and present knowledge is sadly inadequate. We can confidently recommend the use of nitrogen in practically all orchards. In general, the heavier the application (within reason), the greater the yields. But high nitrogen delays maturity, and fruit color may be poor. We can with equal confidence recommend the use of magnesium, potash, and boron when deficiency symptoms appear. But may not a lack of these and perhaps other elements interfere with maximum yields in the absence of clearly defined deficiency symptoms?

**Studies of Varieties of Fruits.** (J. K. Shaw and Staff.) Among the new peach varieties are a number which look promising. Since most of the peaches described below have fruited only one year, the following evaluations are tentative.

No variety earlier than **Oriole** appears worthy of consideration. Most growers do not like Oriole because of its small size and not too attractive appearance. It has been recommended chiefly because of its bud hardiness.

**Fisher**, which ripens with Oriole, may be a substitute although its performance in 1944 was not impressive. It is a sport of Valiant and is supposed to be like that variety in every way except ripening date. The fruit was medium to large, round, fairly attractive and yellow-fleshed, but had a tendency to cling. The flesh was a bit stringy and soft when ripe. There was a marked tendency for the fruit to soften at the tip.

While **Golden Jubilee** is an excellent peach, it softens a little too rapidly to suit most commercial growers. There are two possibilities in its season.

**Raritan Rose**, a cross between J. H. Hale and Cumberland from New Jersey, is a medium to large, well-colored, attractive, white-fleshed, freestone peach. The quality is good, but the flesh tends to be soft and slightly stringy and bruises easily when ripe. It is not impressive but is worth watching if one wants a white-fleshed peach in this season.

**Red Haven**, a cross between Halehaven and Kalhaven from Michigan, is a large, round, very highly colored, very attractive, yellow-fleshed freestone. Since only a few peaches were borne, the size was probably larger than normal. The flesh was firm and the skin thick and tough so that it should fulfill its reputation of being a good shipper. The quality, while not all that could be desired, was fair to good. The tree is said to be hardy and the fruit buds much hardier than Elberta but not so hardy as those of South Haven or Rochester. It is worthy of trial.

Between Golden Jubilee and Halehaven there are three varieties worthy of attention. **Red Rose** is a large, round, high quality, white-fleshed, freestone. It looks very promising as a white-flesh peach ripening just before Halehaven. The fruit is well covered with red and, therefore, very attractive. It softens slowly and should be a good shipper. **Fireglow**, formerly New Jersey No. 71, is a truly handsome peach of unusually high quality where it can be grown. Un-



fortunately, the fruit buds are so tender that they will not survive even an ordinary winter. It is not recommended for Massachusetts. **Golden Globe** is a large, round, very attractive, yellow-fleshed freestone of excellent quality. Unfortunately the fruit buds are rather tender to cold. It probably cannot be successfully grown in Massachusetts except in unusually favorable locations.

**Sunhigh**, a cross between J. H. Hale and 40 CS from New Jersey, is a large, oval, yellow-fleshed freestone. Although the flesh is a bit stringy and a little soft, the quality is good. It ripened with Halehaven in 1944. The trees are still small and the crop was very light.

**Triogem**, a cross between J. H. Hale and Marigold from New Jersey, is a large, yellow-fleshed freestone of very good quality. It is attractive and has firm flesh and thick, tough skin. It is reported to be a good shipper. It ripened with Halehaven in 1944. It is said to require good growing conditions and considerable thinning, to ripen slowly, and to hang to the tree well. It is well worth a trial.

Between Halehaven and Belle of Georgia, there are four varieties worth considering. **Goldencast**, a cross between Elberta and New Jersey No. 38 (an Elberta-Greensboro cross), is a large, round, attractive, yellow-fleshed peach of high quality. It is usually a freestone, although it tends to cling slightly in some seasons. It ripens with Halehaven or a little later. However, it is another one of those peaches with fruit buds not hardy enough for best results in Massachusetts. **Colora**, which ripens with Goldencast and Halehaven, is a very attractive, yellow-fleshed peach of fair quality and size. It tends to soften rapidly and, therefore, is probably not a good shipping peach. Its outstanding quality for Massachusetts is fruit bud hardiness. One grower in Massachusetts had a few peaches after the winter of 1942-43, when other varieties were frozen out. In spite of its weaknesses, it seems worthy of further trial because of its apparent hardiness. **Pacemaker**, a cross between J. H. Hale and Marigold from New Jersey, ripened three days after Goldencast in 1944. The fruit is large, round, firm, attractive, but not as highly colored as some, usually freestone with a slight tendency to cling at times. Quality is good to excellent. The trees are said to be semi-dwarf like J. H. Hale, and the flowers are self-sterile. It deserves further trial. **Summercrest**, a cross between Hale and Cumberland from New Jersey, ripened just after Pacemaker, five or six days ahead of Belle of Georgia. The fruit is large, oval, firm fleshed, and fairly attractive, although the color is not all that could be desired, especially if grown on rich soils or given much nitrogen. It is said to color up much better on thin soils or those low in nitrogen. A thick tough skin together with the firm flesh should make it a good shipper. It is worthy of trial.

**Polly** ripened in 1944 between Summercrest and Belle of Georgia. It is a white-fleshed freestone of very good quality with very soft flesh. It is almost a duplicate of the old Champion. Although it is supposed to be exceptionally hardy in bud, it has not been outstanding in this respect at Amherst. For anyone who wants a white-fleshed peach at this season, a few trees might be considered, but it is much too soft to ship.

**White Hale**, an open-pollinated seedling of J. H. Hale, is one of a growing list of patented peaches. It is a large, round, attractive, white-fleshed, freestone with considerable red around the pit. It resembles J. H. Hale considerably except in flesh color and in having self-fertile flowers. Quality is good but not best. It seems to soften a little too rapidly for a good commercial sort. Ripened with Elberta in 1944.

**Sungold** is a medium to large, round to oval, attractive, yellow-fleshed freestone, of high quality. The skin is thick and tough so that it should be a good shipper. It ripens with Elberta. The tree is rather small and dwarfish like Hale. It is said to be very hardy and, therefore, seems worthy of further trial.

**Fertile Hale**, a whole tree sport of J. H. Hale, is another patented peach. It is a large, round, yellow-fleshed, freestone ripening with Elberta and J. H. Hale. It is only fair in quality and appearance, and resembles Elberta type more than J. H. Hale. Its value is doubtful.

**Afterglow**, a cross between J. H. Hale and New Jersey No. 27116, which ripens a few days after Elberta, is a large, round to oval, firm, yellow-fleshed freestone, with skin medium tough and thick so that it should be a fairly good shipping peach. The flavor while not the best is better than Elberta. It is not so highly colored as some, but is fairly attractive. It deserves further trial.

**Blueberry Culture.** (J. S. Bailey.) Although there were no extremely low temperatures during the winter of 1944-45, what appeared to be winter injury was very severe in the spring of 1945. However, the appearance of many apothecia of the mummy berry disease indicated a very heavy infection and suggested that much of what looked like winter injury might be due to the ravages of this disease. Accordingly, an experiment to control it with fermate was started in cooperation with Dr. Sproston of the Botany Department. Although it is now evident that the first spray was not applied early enough, there was some reduction of the primary infection of twigs and blossoms. It is too early to tell how effective fermate will be in preventing fruit infection.

A scale insect, probably a *Lecanium* sp., appeared on some bushes. Application of D289 spray at the rate of 1 quart per 100 gallons on March 25, 1945, when the buds had nearly reached the delayed dormant stage, reduced the scale by at least 80 percent.

In another part of the planting, blueberry bud mite was found. DN 111 was effective in controlling the mites but caused injury to the leaves and spotting of the fruit.

**Nutrition of the High-Bush Blueberry, Especially in Relation to Soil Reaction.** (J. S. Bailey.) Because of very severe winter injury during the winter of 1943-44, the crop on the manure plots was exceedingly light. Amount of winter injury was not affected by manurial treatment. Some plants are making much poorer growth than others, but this seems to be the result of the type of soil profile. Most of the field is underlaid by a layer of compact, fine, gray sand into which the blueberry roots seldom penetrate. Where this compact layer is less than six inches from the surface, the plants do not grow well.

To test the effect of potassium on the appearance of chlorosis, a number of rooted cuttings were planted in 1-gallon crocks in the greenhouse. The soil was from a section of the field where chlorosis had appeared and was treated with varying amounts of  $K_2SO_4$ . No chlorosis has appeared, even in the untreated soil.

**Preharvest Dropping of Apples.** (L. Southwick.) Tests were made on Wealthy and McIntosh to determine the comparative effectiveness of sprays and dusts containing higher percentages of active chemicals than "standard." With Wealthy, there was a good correlation between spray or dust concentrations and drop control. For example, in one test, treatments and percentages of preharvest drop were as follows: Check, 36; standard spray, 18; triple concentration spray, 8; standard dust, 16; double concentration dust, 12; triple concentration dust, 4.

With McIntosh, the September 14-15 hurricane wind terminated the tests too early for best results. However, in many cases, control of drop was better with the stronger sprays and dusts. Since the wind broke many spurs, the "hormone" applications were not effective in reducing drop during the hurricane.

The data show benefits from stronger sprays and dusts, but whether the benefits would warrant the increased cost of material is not proven. In any case, with McIntosh and Wealthy, it would seem unwise to use less than standard amounts of commercial materials; in many cases, increased concentrations are justifiable on the basis of insurance alone.

A small test on Duchess showed good results with lower than standard concentrations. This variety is much more easily influenced by "hormone" drop control applications than many varieties including McIntosh.

Plans for using a promising, newly exploited chemical in drop-control tests are underway. It is very possible that more effective materials than naphthalene acetic acid will be found.

**Beach Plum Culture.** (J. S. Bailey.) This project was concluded and the results published in Experiment Station Bulletin 422, "The Beach Plum in Massachusetts."

**Control of the Peach Tree Borer.** (J. S. Bailey.) Paradichlorobenzene, ethylene dichloride, and propylene dichloride were applied to peach trees according to standard directions for each. There were so few borers even in the untreated trees, that no indication of their relative effectiveness for borer control was obtained. It is worth noting that none of these materials properly applied caused any injury to the trees.

**Magnesium Deficiency in Massachusetts Apple Orchards.** (L. Southwick.) The inclusion of 20 pounds of Epsom salts per 100 gallons of spray solution in 3 early-season applications was rather effective in preventing the appearance of magnesium deficiency leaf scorch in the year of application. This treatment seems especially valuable for trees which may be slow in responding to soil applications of magnesium materials. As a temporary measure for controlling scorch, it has a definite place, particularly in mature orchards.

Soil applications of Epsom salts and kieserite were beneficial in young, mulched blocks; but one application of dolomite, kieserite, or Epsom salts was rather ineffective in a seriously deficient bearing orchard under sod culture. The application of commercial magnesium oxide (92 percent MgO) appeared to result in greater increases of magnesium in apple leaves on young trees than the use of Epsom salts applied in similar amounts by weight. Results with magnesium oxide on older trees have not been obtained. Commercial dolomite (magnesium limestone) has seemed to be less beneficial than other materials, even when used in relatively large amounts.

Although some time may elapse before applications become effective, the use of magnesium lime is recommended in most orchards where magnesium deficiency symptoms have appeared. Its use in other orchards is suggested as a means of preventing the deficiency. Prevention is possible and is preferable to allowing the trouble to appear and then trying to correct it. A report of several field experiments will be published in Volume 46 of the Proceedings of the American Society for Horticultural Science.

**Thinning Apples with Caustic Sprays.** (J. K. Shaw.) Attempts to thin apples in 1944 by spraying with Elgetol at blooming time were partially successful. The trees receiving a second application and those receiving the stronger concentration required less thinning. The apple bloom in 1945 was light, and most



of the trees sprayed in 1944 failed to blossom at all. Two or three that had received the heavier sprays had a light bloom, but the sprays were not generally successful in causing annual cropping.

Experiments in 1945 were interfered with by the freeze of April 23. Naphthalene acetic acid sprays applied at concentrations of 10, 20, and 30 p.p.m. apparently reduced set in all cases. Effectiveness seemed to depend more on variety than on concentration. Wealthy and Baldwin were thinned less than Melba and Early McIntosh. Spur leaves seemed to show some dwarfing injury and this also seemed to depend more on variety than on concentration, Melba showing the most injury. This limited experience gives some hope that this material has value as a blossom thinning spray.

**Killing Poison Ivy.** (L. Southwick.) Following two yearly applications of ammonium sulfamate to poison ivy under apple trees, there is only slight indication of recovery (July 1). If the ivy makes any growth the year following treatment, experience seems to show that it will continue to grow and spread. In short, treatment is needed until there is no recovery. Probably one pound of the chemical per gallon of water is best. Other promising materials are now being developed and further experimental tests are under way.

**Chemical Control of Weed Grasses.** (L. Southwick.) In the effort to subdue grass growth around the bases of young apple trees in sod, an application of ammonium sulfamate was made on a quiet, hot, humid day in August 1944, to an area about 5-6 feet in diameter. One pound of chemical was used in one gallon of water and a small amount of a special wetting agent was included. A fairly drenching application was made. The grass was killed and showed very little recovery up to July 1, 1945. Apparently no injury to the trees resulted even though the spray got on the trunk bark. This method may prove to be a good substitute for cultivation or hand hoeing around young trees.

A similar test of this material in May 1945 on the sod strip along a row of blueberries resulted in severe damage to the bearing blueberry bushes. Within 2 or 3 days the foliage began to take on a reddish hue and it now appears that the bushes may be killed. Probably the shallowness of the blueberry root system was a factor. This experience shows the necessity for careful testing before toxic chemicals are used in the commercial or home fruit planting.

Further work on weed and grass control is under way with several promising materials.

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## DEPARTMENT OF POULTRY HUSBANDRY

F. P. Jeffrey in Charge

**Broodiness in Poultry.** (F. A. Hays.) The major objective is to develop a line of Rhode Island Reds that never exhibits the broody instinct. The mode of inheritance of broodiness is rather well understood, but there are several obstacles yet to be overcome. The majority of the females that carry a broody inheritance exhibit the instinct in the first laying year; yet there are some individuals that fail to display broody behavior even in two or three years of laying that will, if retained longer, become broody. Degree of broodiness is governed by inherited factors. The problem of testing for deferred broodiness and of breed-testing all males is the chief concern at present.

The generation hatched in 1941 consisted of 55 females, one of which exhibited broodiness in the first laying year. The generation hatched in 1942 (106 females) exhibited no broodiness the first year. The generation hatched in 1943, made up

of 79 females, actually disclosed four broody individuals—a result which would be expected to occur only when breeding females are not fully tested for deferred broodiness and when breeding males are inadequately progeny tested. The 1944 generation includes 67 females now being tested.

**Effectiveness of Selective Breeding to Reduce Mortality.** (Regional Poultry Research Laboratory and Departments of Veterinary Science and Poultry Husbandry, Massachusetts Agricultural Experiment Station cooperating.) Results of this project for eight generations hatched from 1935 to 1942 were published in Bulletin 420.

To produce the generations hatched in 1943, 1944, and 1945, the plan of breeding has been changed. A low mortality line has been reproduced from yearling males and females within the line so that inbreeding has been necessary. A high mortality line has been reproduced from young males and females within the line and inbreeding has been practiced. The sole basis of selection in both lines has been the mortality rate. Results thus far suggest that selective breeding may be effective in producing two lines that differ significantly in mortality rates to the age of 18 months.

**Genetic Laws Governing the Inheritance of High Fecundity in Domestic Fowl.** (F. A. Hays and Ruby Sanborn.) In Bulletin 423 it was shown that at least sixteen different factors may affect egg production. These factors are in part environmental, but probably in greater part are governed by inheritance. Among the most important new characters are spring, summer, and fall intensity. Of considerable importance also are spring and summer pause duration. Special attention is now being given to the inheritance phase of spring, summer, and fall intensity.

The primary sex ratio in chickens has been studied for the first time and evidence of a 50-50 sex ratio reported.

A line of birds carrying only autosomal gene  $E'$  for early sexual maturity has been developed. Such females attain sexual maturity at from 190 to 200 days of age. When sex-linked gene  $E$  was present with gene  $E'$ , the mean age at sexual maturity was reduced to 170-175 days. When neither gene for early sexual maturity was present, the age at sexual maturity ranged from 200 to 300 days.

**A Study of Fertility Cycles in Males.** (F. A. Hays.) Results reported for the hatching season of 1944 suggest that sex hormones may have some value in stimulating males that are at least 36 months old to active spermatogenesis. They had no value for younger males. This test was repeated in 1945 using a higher dosage of sex hormone and more artificial illumination. Results were entirely negative in this second test and fertility stood at the same level in hormone-treated, artificially lighted, and control pens.

**A Genetic Analysis of Rhode Island Red Color.** (F. A. Hays.) Colorimetric studies on feather pigment from three generations indicate that dense pigmentation in darker colored birds is due to several recessive genes. Further study is being given to this phase of the problem.

**Secondary and Adult Sex Ratio in Relation to Hatchability.** (F. A. Hays.) High and low hatchability lines were started in the spring of 1945. A complete record of sex is being secured on all dead embryos from the ninth day on and upon all chicks up to the adult stage of sexual maturity.

**A Study of Egg Characters of the Domestic Fowl.** (F. P. Jeffrey.) Nine hundred and sixteen pedigreed R. I. Red pullets from 161 dams and 22 sires have been classified as to egg weight, degree of shell color, egg shape, percentage egg shell,

condition of firm albumen, shade of shell color, and incidence of blood spots, meat spots, blemished yolk, and fishy odor. Correlation analyses will be run to determine whether any significant relationships exist between any of these ten characters. Each character will be tested for heritability on the basis of sire progenies.

**Methods of Feeding.** (John H. Vondell.) Eight pens of R. I. Red pullets were fed as follows: four pens were hopper fed (free choice) mash, whole corn, oats, and wheat; two pens were hopper fed mash and hand fed scratch feed; and two pens were fed complete all mash. The feeding methods were compared for the following factors: egg production, mortality, egg weight, body weight, feed consumption per bird, feed to produce a dozen eggs, protein intake, and costs and returns. The test ran from December 1 to September 1.

Average egg production varied less than 4 percent for the three methods, and egg weight less than 1 percent. Mortality averaged 19 percent for the hopper-fed pens, 17 percent for the scratch and mash, and 13 percent for the all-mash. The scratch and mash ration seemed to maintain body weight best, with the all-mash ration poorest. Feed consumption ran 71.27 pounds per bird for the all-mash, 75.81 for the hopper-fed, and 79.05 for the scratch and mash. The hopper-fed birds required 6.39 pounds of feed per dozen eggs, the all-mash 6.47 pounds, and the scratch and mash 6.61 pounds. The protein intake averaged 14.08 percent for the hopper-fed birds, 16.28 percent for the scratch and mash, and 16.68 percent for the all-mash. Net return per bird over feed cost was \$2.77 for the hopper-fed, \$2.58 for the scratch and mash, and \$2.38 for the all-mash.

The test is being continued.

**Comparison of Four Strains of Broiler Chicks.** (John H. Vondell.) Four strains of commercial broiler chicks were kept under identical conditions and grown through 13 weeks. One strain proved vastly superior in growth, feed efficiency, and dressed grade. The return above feed cost for the four strains was \$72.93, \$86.39, \$78.99, and \$106.05.

**Poultry Housing Projects.** A. (C. I. Gunness and W. C. Sanctuary.) The non-insulated pen previously described (Bulletin 417:67) produced favorable results in terms of litter condition, ceiling condition, and general welfare of birds. This test was not complicated this past winter by water coming through foundations during heavy rains. Adequate drainage prevented the trouble.

B. (W. C. Sanctuary.) Of the two pens under comparison, one (No. 28) was especially arranged to increase housing capacity. The nests were on the rear wall, the pits (roosting quarters), water fount, and hoppers were elevated to give more floor space, and the rear ventilators were near the floor. The other pen (No. 27) had the usual placement of equipment, with floor pit and hoppers on the floor and the rear ventilators (of the same area as those in pen 28) as high as the ceiling would permit. The birds were allowed only three square feet of floor space per bird in each pen.

Both pens were equipped with the baffled window ventilators, and no change in ventilation adjustments was made for the second winter. With no addition of litter after early November, because none was to be had, little building up of litter was possible. The moisture content of the litter became as high as 41 percent, with some caking of the surface. The air was drier in these pens (75 percent humidity) than in other pens which were less crowded.

To June 9, 1945, the birds in pen 28 had laid 8 eggs more per bird than those in pen 27, and the mortality was 3 less than in pen 27. The preceding year, with no crowding, both pens laid practically the same.



## DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

**Poultry Disease Control Service.** (H. Van Roekel, K. L. Bullis, O. S. Flint, and M. K. Clarke.)

1. *Pullorum Disease Eradication.* During the 1944-45 season, a record number of flocks (529) and samples (975,041) have been tested. The percentage of reactors detected among chickens was 0.12. It is encouraging to note that progress in eradication is being made, as is indicated by the fact that 93 percent of all birds tested are in 100 percent tested, non-reacting flocks.

Furthermore, there was a considerable increase in turkeys tested during the past season, due in large measure to the recent marked expansion in the turkey industry. Unfortunately, the pullorum status in turkey flocks in Massachusetts is not so encouraging as it is in chickens. However, this situation may be improved by working in closer cooperation with the flock owners and through more effective education regarding pullorum disease eradication and prevention.

It has been extremely difficult to meet the testing demand during the past year. Most of the flocks, however, were tested without serious delay. This was made possible by the willingness of the testing personnel to put forth extra effort in the collection and testing of the samples.

A detailed report of the 1944-45 testing season has been published in Control Series Bulletin 124.

2. *Diagnostic Service.* A total of 3801 specimens was received during 1944 in 716 consignments, of which 360 were delivered in person. The specimens were classified as follows:— 3221 chickens, 451 turkeys, 23 quail, 22 fish, 21 ducks, 13 rabbits, 12 bovine semen, 8 foxes, 7 swine, 6 guinea pigs, 3 each of canine feces and geese, and 1 each of the following: canary, canine, feline sputum, goat, goat feces, horse meat, ovine semen, pheasant, pigeon, porcine semen, and sheep.

Coccidiosis (121), tumors (70), infectious bronchitis (49), fowl paralysis (36), internal parasites (32), pullorum disease (31), and fowl cholera (29) were the disease disturbances encountered most frequently. The tumors were classified on the basis of gross examination as follows: 26 lymphocytoma, 14 myelocytoma, 9 hemangioma, 8 embryonal nephroma, 3 fibrosarcoma, 2 each of carcinoma and heart tumor, and 1 each of chondrosarcoma, hematoma, leiomyoma, and myxoma.

The tumors identified as hemangioma represent an interesting problem which is of consequence in some flocks. One owner reported a loss of 25 out of 200 pullets between the ages of five and eight months. Sporadic cases only are noted in most of the cases directed to our attention. Affected birds show a small raised opening in the skin which bleeds recurrently. The site of bleeding has been observed on various parts of the body, including the feet, legs, breast, and head of different birds. Afflicted birds usually die within a month from loss of blood. In some cases there is metastasis of the tumor to the liver, spleen, kidneys, and other internal organs. It is possible to salvage a bird by excising the tumor in the skin if metastasis has not occurred.

The incidence of fowl cholera was greater than in any previous year and infection was detected on 19 new premises. Fowl typhoid was observed much more frequently than in any year since 1939 and occurred in widely separated places within the State. One case of avian tuberculosis was identified. No paratyphoid infection in chickens was brought to the attention of the laboratory. There has been an increase in the incidence of avitaminosis A during the past two years and a dermatitis syndrome believed to be due to deficiency of pantothenic acid and biotin has been observed more frequently.

Additional field observations have been made on a disease disturbance in chicks caused by exposure to coal-tar creosote oil, which was reported last year. It appears probable that strong coal-tar disinfectants, so-called gas house tar, and kerosene improperly used may cause the same type of injury.

The 451 turkeys were received in 84 consignments which represents the largest number ever received at the laboratory in one year. Coccidiosis, enterohepatitis, pullorum disease, and paratyphoid were the diseases encountered most frequently. An examination of the records for the past ten years reveals that diseases which were unidentified or were directed to the attention of the laboratory only infrequently at the beginning of the period are now of major importance to the turkey industry. A list of such diseases includes coccidiosis, hexamitiasis, infectious sinusitis, moniliasis, paratyphoid infection, pullorum disease, swine erysipelas, trichomoniasis, ulcerative enteritis, and so-called unknown disease (blue comb).

Two cases each of fowl cholera and fowl typhoid were identified in turkeys during the year. A considerable number of cases revealed heavy infestations in the lower digestive tract with motile protozoa which were identified as trichomonads. The observations suggest that these protozoa are pathogenic for turkeys and in a number of cases it has appeared that they were responsible for diarrhea, retarded growth, and mortality in poults. The infections with trichomonads are sometimes combined with coccidiosis and hexamitiasis, but frequently the trichomonads appear to be the principal cause of disease outbreaks. Microorganisms apparently belonging to the aerobic actinomycetes group were recovered from two outbreaks of respiratory disease in turkeys.

3. *Flock Mortality Studies.* From the Experiment Station flock hatched in the spring of 1943, 368 morbid and dead birds have been examined—227 females and 141 males. Cannibalism (56), reproductive disorders (50), tumors and leukemia (46), fowl paralysis (21), and kidney disorders (17) were the conditions most frequently encountered among the females. Cannibalism (81), bacterial and mycotic diseases, principally staphylococcosis, (17), and kidney disorders (12) accounted for 70 percent of the diagnoses among the males. The tumorous conditions in the population were identified on the basis of gross examination as 17 lymphocytoma, 8 leiomyoma, 5 each carcinoma and embryonal nephroma, 4 each myelocytoma and unidentified, 3 hemangioma, 2 leukemia, and 1 each cyst-adenoma and neurogenic sarcoma. The majority of cases identified tentatively as fowl paralysis failed to show gross lesions. Diagnoses of cannibalism and reproductive disorders among the females were most frequent during a period of six months, which began about three months after production started.

*Erysipelothrix rhusiopathiae* was identified in one seven-months-old male. The liver and spleen were slightly swollen and the heart muscle showed pale areas.

4. *Infectious Bronchitis* During 1944, 232 flocks representing approximately 400,000 birds were enrolled in the infectious bronchitis control program. These flocks were located in Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, and Plymouth counties. The procedure of the program was much the same as in 1943, except that the service was placed on a fee basis.

The results on the whole were satisfactory although in a few instances respiratory symptoms developed following the recovery from the infectious bronchitis inoculation. The cause of the disturbance was not definitely identified. It appeared that in some of these cases the infection was either an atypical form of infectious bronchitis or some other respiratory infection which has not been identified up to the present.

In some flocks complications resulted from the fact that birds of an undesirable age were inoculated. Also the condition of the flock and the season of the year had a definite influence on the results. The most satisfactory results are obtained when the birds are 10 - 14 weeks of age, in good health, and inoculated on range in June, July, and August when the weather is apt to be favorable.

This control program is in need of many refinements. Work is in progress to develop an immunizing procedure which will eliminate the possible hazard of dissemination.

5. *Farm Department Brucellosis Control and Eradication.* The laboratory tested 369 bovine and 33 porcine blood samples by the standard tube agglutination method during the 1944 calendar year.

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### WALTHAM FIELD STATION

Waltham, Massachusetts

Ray M. Koon in Charge

The members of the research staff of the Waltham Field Station are assigned to this branch by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Refer to reports of these departments for results of investigations conducted at this Station.

**Soil Testing Service.** Commercial vegetable growers, mushroom growers, florists, nurserymen, and vendors of loam brought in 2918 samples of soil for testing and interpretation. For home gardeners, 3291 samples were tested.

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### PUBLICATIONS

#### Bulletins

- 417 Annual report for the period ending June 30, 1944. 78 pp. August 1944.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

- 418 The propagation and identification of clonal rootstocks for the apple. By J. K. Shaw. 23 pp. illus. August 1944.

There is a demand, far exceeding the supply, for clonal rootstocks for growing dwarf and semi-dwarf apple trees. This bulletin tells how they are grown and how the different kinds may be identified, thus helping to keep these rootstocks true to name.

- 419 Trellis tomatoes. By Robert E. Young. 19 pp. illus. November 1944.

The tomato is one of the most important vegetable crops in Massachusetts, and the details of its culture are of significant economic interest. This deals with the operation of a practice which has been growing in favor.

- 420 Mortality studies in Rhode Island Reds. By F. A. Hays. 20 pp. illus. November 1944.

Mortality from all causes is one of the most important problems of poultrymen. This report is intended to add something to the very limited information on the role of breeding in reducing mortality.



- 421 The identification of pear varieties from non-bearing trees. By Lawrence Southwick, A. P. French, and O. C. Roberts. 51 pp. illus. November 1944.

The identification of varieties before fruit trees leave the nursery is important if disappointments in the orchard are to be avoided. This bulletin considers the characteristics by which nursery pear trees may be identified and records descriptions of 47 varieties and photographs of 41 varieties.

- 422 The beach plum in Massachusetts. By John S. Bailey. 16 pp. illus. December 1944.

The beach plum industry on Cape Cod and the islands of Nantucket and Martha's Vineyard has developed to the point where there is a demand for improved plums and better methods for growing them. This bulletin reports work done to satisfy this demand.

- 423 Factors affecting annual egg production. By F. A. Hays. 12 pp. December 1944.

Modern methods of poultry breeding are based on specific characters that affect egg production. This study was undertaken for the purpose of developing more accurate methods of selecting birds for breeding purposes where the primary object is increased egg production.

- 424 The culture of set onions in the Connecticut Valley. By W. G. Colby, C. J. Gilgut, and H. M. Yegian. 16 pp. illus. April 1945.

The weather conditions peculiar to the Connecticut Valley and cultural practices influenced thereby have a definite effect on the yield, appearance, and keeping quality of onions. These practices and their influence are discussed here.

- 425 Grass silage. By J. G. Archibald and C. H. Parsons. 11 pp. illus. April 1945.

The storing of grass and legume crops as silage has become an accepted practice. This bulletin, a revision of an earlier issue, reports the most recent findings on the subject.

- 426 Botulism and home canning. By William B. Esselen, Jr. 28 pp. April 1945.

In order to answer some of the many questions which have been raised concerning botulism and home-canned foods, a summary of available information is presented.

- 427 Carnation wilt diseases and their control. By E. F. Guba. 64 pp. illus. June 1945.

Wilt diseases cause serious losses in greenhouse carnation culture in Massachusetts. This bulletin is intended to help the carnation grower understand these diseases and to acquaint him with proven control measures.

### Control Bulletins

- 120 Twenty-fourth annual report of pullorum disease eradication in Massachusetts. By the Poultry Disease Control Laboratory. 12 pp. July 1944.
- 121 Inspection of commercial feedstuffs. By Feed Control Service Staff. 28 pp. September 1944.
- 122 Inspection of commercial fertilizers and agricultural lime products. By Fertilizer Control Service Staff. 28 pp. September 1944.
- 123 Seed inspection. By F. A. McLaughlin. 41 pp. December 1944.

### Meteorological Bulletins

- 661-672, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By C. I. Gunness. 4 pp. each.

## Reports of Investigations in Journals

## NUMBERED CONTRIBUTIONS

- 497 Performance studies on home dehydrators. By W. B. Esselen, Jr., S. G. Davis, and M. A. Ewing. *Food Res.* 9 (5):341-347. 1944.
- 501 Corn distillers' by-products in poultry rations. I. Chick rations. By Walter L. Nelson, F. E. Volz, Raymond T. Parkhurst, and Leonard R. Parkinson. *Poultry Sci.* 23 (4):278-286. 1944.
- 507 Ratio of soluble sugars, pectic materials, and hemicelluloses to nitrogen-free extract of some common vegetables. By Emmett Bennett. *Food Res.* 9 (6):462-464. 1944.
- 508 The significance of inherited characters affecting egg production. By F. A. Hays. *Poultry Sci.* 23 (4):310-313. 1944.
- 509 Influence of calcium and magnesium upon composition of Boston head lettuce. By Arthur D. Holmes and Leo V. Crowley. *Food Res.* 9(5):418-426. 1944.
- 510 The value of starfish meal in the poultry starting ration. By Roy E. Morse, Francis P. Griffiths, and Raymond T. Parkhurst. *Poultry Sci.* 23 (5):408-412. 1944.
- 511 Preventing surface darkening in certain home-canned foods. By J. J. Powers and C. R. Fellers. *Jour. Home Econ.* 37 (5):294-296. 1944.
- 513 The ratio of ascorbic, nicotinic, and pantothenic acids, riboflavin and thiamin in late summer milk. By Arthur D. Holmes, Carleton P. Jones, Anne W. Wertz, Katherine Esselen and Beula V. McKey. *Jour. Dairy Sci.* 27 (10):849-855. 1944.
- 514 The determination of tannic substances in commercial cocoa powders. By W. S. Mueller and J. W. Kuzmeski. *Jour. Dairy Sci.* 27 (11):897-901. 1944.
- 515 The effect of institutional cooking methods on the vitamin content of foods. I. The thiamine content of potatoes. By Anne W. Wertz and C. Edith Weir. *Jour. Nutr.* 28 (4):255-261. 1944.
- 516 Retention of vitamin C in foods by the use of natural gas atmosphere in dehydration. By H. L. Titus, Owen J. Brown, Jr., John Wertheim, Laurel M. Skofield, Roy E. Morse and Francis P. Griffiths. *Chemical Products*, November-December, 1944.
- 517 Some aspects of the metabolism of the Ebenezer onion. By Emmett Bennett. *Plant Physiol.* 20 (1):37-46. 1945.
- 518 Home canning. I. Survey of bacteriological and other factors responsible for spoilage of home-canned foods. By R. G. Tischer and W. B. Esselen, Jr. *Food Res.* 10 (3):197-214. 1945.
- 519 Home canning. II. Determination of process times for home-canned foods. By W. B. Esselen, Jr., and R. G. Tischer. *Food Res.* 10 (3):215-226. 1945.
- 520 Corn distillers' by-products in poultry rations. II. Laying and breeding rations. By Raymond T. Parkhurst, Carl R. Fellers and John W. Kuzmeski. *Poultry Sci.* 24 (1):8-19. 1945.
- 522 Sulfur compounds as disinfecting agents for dairy equipment. By W. S. Mueller, Emmett Bennett, and James E. Fuller. *Jour. Dairy Sci.* 27 (12):1007-1009. 1944.
- 524 Effect of ascorbic acid injections on the amount in the blood plasma of laying hens. By G. Howard Satterfield, Thomas A. Bell, F. W. Cook, and Arthur D. Holmes. *Poultry Sci.* 24 (2):139-141. 1945.
- 526 The serial passage of an avian lymphoid tumor of the chicken. By Carl Olson, Jr. *Cancer Res.* 4 (11):707. 1944.

- 527 The vitamin content of commercial winter goat's milk. By Arthur D. Holmes, Harry G. Lindquist, Carleton P. Jones, Anne W. Wertz, Katherine Esselen, Beula V. McKey, and Evelyn Fuller. *N. E. Jour. Med.* 232:72-76. 1945.
- 528 Male sex hormones and artificial light as activators in the spermatogenesis of adult males. By F. A. Hays. *Poultry Sci.* 24 (1):66-71. 1945.
- 529 The fractionation of phosphorus compounds in certain vegetables. By Emmett Bennett. *Jour. Nutr.* 28 (4):269-271. 1944.
- 530 Effect of high-temperature-short-time pasteurization on the ascorbic acid, riboflavin and thiamin content of milk. By Arthur D. Holmes, Harry G. Lindquist, Carleton P. Jones, and Anne W. Wertz. *Jour. Dairy Sci.* 28 (1):29-33. 1945.
- 531 Ascorbic acid, riboflavin and thiamine content of chocolate milk. By Arthur D. Holmes, Carleton P. Jones, Anne W. Wertz, and W. S. Mueller. *Amer. Jour. Dis. Children* 69:157-159. 1945.
- 532 Carbonic anhydrase in the calcification of the egg shell. By Marie S. Gutowska and Carl A. Mitchell. *Poultry Sci.* 24 (2):159-167. 1945.
- 533 Uncommon pathological conditions in chickens and turkeys. By K. L. Bullis and H. Van Roekel. *Cornell Vet.* 34 (4):313-320. 1944.
- 534 Vitamin K content of dairy and cacao products. By W. S. Mueller and Anne W. Wertz. *Jour. Dairy Sci.* 28 (2):167-168. 1945.
- 535 The species specificity of a lymphoid tumor of the chicken. By Carl Olson, Jr. *Cornell Vet.* 34 (4):278-280. 1944.
- 536 The immunizing action of a lymphoid tumor in chickens. By Carl Olson, Jr. *Amer. Jour. Vet. Res.* 6 (19):103-106. 1945.
- 537 d-Isoscorbic acid as an antioxidant. By W. B. Esselen, Jr., J. J. Powers, and R. Woodward. *Indus. and Engin. Chem.* 37:295-299. 1945.
- 539 A second report on some lethal rootstock-scion combinations. By J. K. Shaw and L. Southwick. *Amer. Soc. Hort. Sci. Proc.* 45 (1944):198-202. 1945.
- 541 Chlorine gas injures trees. By Linus H. Jones and Malcolm A. McKenzie. *Arborist's News* 9 (12):89-90. 1944.
- 542 Effect of sunshine upon the ascorbic acid and riboflavin content of milk. By Arthur D. Holmes and Carleton P. Jones. *Jour. Nutr.* 19 (3):201-209. 1945.
- 543 The use of oil sprays as selective herbicides for carrots and parsnips. By William H. Lachman. *Amer. Soc. Hort. Sci. Proc.* 45 (1944):445-448. 1945.
- 544 Methyl bromide as a fumigant for rats and mice in apple cold storages. By Robert M. Borg and Lawrence Southwick. *Amer. Soc. Hort. Sci. Proc.* 45 (1944):146-150. 1945.
- 546 The primary sex ratio in domestic chickens. By F. A. Hays. *Amer. Nat.* 79:184-186. 1945.
- 547 Seepage losses from a silo. By J. G. Archibald and C. I. Gunness. *Jour. Dairy Sci.* 28 (4):321-324. 1945.
- 549 Effect of storage conditions and type of container on stability of carotene in canned vegetables. By J. E. W. McConnell, W. B. Esselen, Jr., and N. Guggenberg. *Fruit Prod. Jour. and Amer. Food Mfr.* 24 (5):133-135. 1945.
- 554 Propagating the high-bush blueberry by softwood cuttings. By W. L. Doran and J. S. Bailey. *Amer. Nurseryman* 81 (7):10. 1945.
- 555 Vegetables as a source of spoilage bacteria in home canning. By Celeste Dubord and William B. Esselen, Jr. *Jour. Home Econ.* 37 (4):221-224. 1945.



- 557 A study of methods of clarification and blends of Massachusetts apples for apple juice. By William B. Esselen, Jr. *Fruit Prod. Jour. and Amer. Food Mfr.* 24 (6):165-168, 189. 1945.
- 560 The requirement for calcium during growth. By Julia O. Holmes. *Nutr. Abs. and Rev.* 14:597-612. 1945.
- 563 Revealing study of plant bands. By Linus H. Jones. *Horticulture* 23 (12):316. 1945.

## UNNUMBERED CONTRIBUTIONS

- Feeding the dairy goat. By J. G. Archibald. *Amer. Dairy Goat Yearbook* 3:87-92. 1945.
- Distribution of the Dutch elm disease in Massachusetts. By Malcolm A. McKenzie. *Newsletter, Mass. Tree Wardens' and Foresters' Assoc.* (mimeo.) February 15, 1945.
- Present status of the Dutch elm disease in Berkshire County. By Malcolm A. McKenzie. *May Cuttings from the Berkshire Garden Center* 5:1:6. 1945.
- Dairy products builders of health and economic welfare. By J. H. Frandsen. *The Milk Dealer* 33 (12):54-55, 1944; *The Milk Plant Monthly*, October 1944, pp. 51 and 58.
- Butter from goat's milk. By H. G. Lindquist. *The Rural New Yorker*, September 1944, pp. 408-409.
- Fruit insect problems of 1943. A. I. Bourne and W. D. Whitcomb. *Mass. Fruit Growers' Assoc. Ann. Rpt.* 50:41-44. 1944.
- Toxicity of natural and synthetic cryolites to rats. By Harvey L. Sweetman and A. I. Bourne. *Jour. Econ. Ent.* 37:299. 1944.
- Observations on bee repellents. By F. R. Shaw and A. I. Bourne. *Jour. Econ. Ent.* 37:519-521. 1944.
- Effects of different insecticides on honeybees. By F. R. Shaw and A. I. Bourne. *Gleanings in Bee Culture* 72 (4):125. 1944.
- Report on castor insecticides. By A. I. Bourne. *A. I. F. News* 2 (6): April 1944.
- Spray schedules for fruits. By A. I. Bourne. (For the Sun Oil Company.)
- The protective value of asphalt laminated paper against certain insects. By Harvey L. Sweetman and A. I. Bourne. *Jour. Econ. Ent.* 37:605-609. 1944.
- Cabbage maggots in the winter. By W. D. Whitcomb. *Horticulture* 22 (17): 386. 1944.
- Better frozen berries for the locker plant. By Francis P. Griffiths. *Quick Frozen Foods* 6 (12):50, 77. 1944.
- How to sell home freezers. By Francis P. Griffiths. *Quick Frozen Foods* 7 (5): 32-33. 1944.
- Research on Massachusetts apples and apple products. 1927-1944. By Department of Food Technology. *Mass. Fruit Growers' Assoc. Rept.* 51st Ann. Meeting, January 1945. pp. 27-35.
- Relationship between calcification of eggshell and carbonic anhydrase activity. By Marie S. Gutowska and U. C. Pozzani. *Federation Proceedings* 4 (1):91-92. 1945.
- Rebuilding Poland's poultry industry to provide eggs for children's health. By Marie S. Gutowska. *World's Poultry Sci. Jour.* 1 (1):17-21. 1945.
- Nutrition research in Poland. By Marie S. Gutowska. *Bulletin of the Polish Institute of Arts and Sciences in America.* 1945.
- Calcium and phosphorus. By Julia O. Holmes. A treatise appearing in *Dietotherapy—Clinical application of modern nutrition*, edited by M. Wohl. pp. 147-188. Saunders, 1945.

- New developments in nutrition research. By Julia O. Holmes. An address before the National Dairy Council Summer Conference, Chicago, June 1944. Milk Plant Monthly, February 1945.
- The Butternut squash. By Robert E. Young. Flower Grower, April 1945, p. 192.
- Chemical weeding of carrots and parsnips with oil sprays. By W. H. Lachman. New England Homestead 118 (1):10-11. 1945.
- Weed control in vegetable growing. By W. H. Lachman. New England Homestead 118 (5):4. 1945.

### Mimeographed Circulars

- Tree lessons from the hurricane applied to Dutch elm disease control. By Malcolm A. McKenzie. October 1, 1944.
- Don't cut elm. By Malcolm A. McKenzie. January 2, 1945.
- Progress reports issued under the National Cooperative Project, Conservation of Nutritional Value of Foods.
- The effect of institutional cooking methods on the vitamin content of food.
- I. The thiamine and ascorbic acid content of potatoes. By A. W. Wertz and C. E. Weir. Mass. Agr. Expt. Sta. Prog. Note 1, 3 pp. 1944.
  - II. Thiamine, nicotinic acid, and panthothenic acid content of beans. By A. W. Wertz, B. V. McKey, K. O. Esselen, and J. O. Holmes. Mass. Agr. Expt. Sta. Prog. Note 2, 3 pp. 1944.
  - III. Thiamine, riboflavin, nicotinic acid, and pantothenic acid content of fish. By A. W. Wertz, B. V. McKey, K. O. Esselen, and J. O. Holmes. Mass. Agr. Expt. Sta. Prog. Note 3, 4 pp. 1944.

### Extension Publications

The following Extension Leaflets and Circulars were prepared wholly or in part by members of the Experiment Station staff:

- Mexican bean beetle. By A. I. Bourne. Mass. State Col. Ext. Spec. Cir. 15 (mimeographed). Revised, 1944.
- Apple maggot. By A. I. Bourne. Mass. State Col. Ext. Spec. Cir. 9 (mimeographed). Revised, 1944.
- Control of weeds in carrot and parsnip fields with oil spray. By W. H. Lachman. Mass. State Col. Ext. Spec. Cir. 120. 1945.
- Control of cutworms. By A. I. Bourne. Mass. State Col. Ext. Leaflet 70. Revised, 1944.
- Apple Pests. By A. I. Bourne, O. C. Boyd, O. C. Roberts, and W. D. Whitcomb. Mass. State Col. Ext. Leaflet 189. Revised, 1944.
- Pest control in the home garden. By A. I. Bourne and O. C. Boyd. Mass. State Col. Ext. Leaflet 171. Revised, 1944.





## Annual Report

For the Fiscal Year Ending June 30, 1946

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

MASSACHUSETTS STATE COLLEGE

AMHERST, MASS.

AUG 7 1947

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

STATE HOUSE, BOSTON

Trustee Committee on Experiment Station

MASS OFFICIALS

	Term Expires
MALCOLM, DAVID J., Charlemont, <i>Chairman</i> .....	1946
COLE, FREDERICK E., <i>Commissioner of Agriculture</i> .....	
HUBBARD, CLIFFORD C., Mansfield .....	1946
WHITMORE, PHILIP F., Sunderland.....	1948
BRETT, ALDEN C., Belmont.....	1950
HOFTYZER, ERNEST, Wellesley .....	1950
McNAMARA, MRS. ELIZABETH L., Cambridge.....	1951

Experiment Station Staff, June 30, 1946

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GASKILL, EDWIN F., Assistant to the Director  
O'DONNELL, MARGARET H., Secretary

HAWLEY, ROBERT D., Treasurer  
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†DEMPSEY, PAUL W., Horticulture

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JONES, LINUS H., Botany  
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LEVINE, ARTHUR S., Food Technology  
McLAUGHLIN, FREDERICK A., Seed Law  
MUELLER, WILLIAM S., Dairy Industry  
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SPELMAN, ALBERT F., Feed and Fertilizer Laws  
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†WHITE, HAROLD E., Floriculture  
†YOUNG, ROBERT E., Olericulture  
  
ANDERSON, JESSIE L., Seed Law  
†BEMBEN, PETER M., Olericulture  
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CLARKE, MIRIAM K., Veterinary Science  
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†DONNELLY, EDWARD B., Floriculture  
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†GARLAND, WILLIAM, Entomology  
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JEWETT, FELICIA, Veterinary Science  
†KELLEY, JOSEPH L., Cranberries  
KUCINSKI, KAROL J., Agronomy  
LOVELL, MILTON F., Poultry Husbandry  
MARTELL, JOSEPH A., Dairy, Feed, and Fertilizer Laws  
McCONNELL, JOHN E. W., Food Technology  
MINER, GLADYS I., Botany  
MOLINE, JESSIE, Botany  
PARKINSON, LEONARD R., Home Economics Nutrition  
ROBERSON, ELAINE M., Agricultural Economics and Farm Management  
ROSENTHAL, JUDITH E., Agricultural Economics and Farm Management  
SANBORN, RUBY, Poultry Husbandry  
SHERBURNE, RUTH E., Economics  
SPEAR, ARTHUR J., Home Economics Nutrition  
WEEKS, WALTER D., Pomology  
WHITE, W. HENRY, Botany  
†WILSON, HAROLD A., Horticulture  
YEGIAN, HRANT M., Agronomy

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# ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1945-46

## DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

**Development of Statistical Data as Controls to Livestock Production Program.** (A. A. Brown, Elaine M. Roberson, and Judith E. Rosenthal.) The field work phase of this project is completed and 941 farms in the "6% sample" have been classified by major source of income. These farms fell into the following classifications:

Dairy.....	239	Ducks, Turkeys, Broilers.....	13
Poultry.....	104	Miscellaneous.....	10
Poultry with other Livestock....	30	Rural Residence with Livestock....	198
Tobacco, potatoes, or crops.....	42	Rural Residence without Live-	
Vegetables.....	47	stock.....	235
Fruit.....	13	Estates.....	10

In statistical tests applied to the "6% Sample", the New England Crop Reporting Service Sample, and the "10% sample" of cow numbers, the differences between means fell below the 1 percent level of significance, indicating that the samples were drawn from the same population. The same results were obtained in the comparison of chicken numbers of the New England Crop Reporting Service sample and the "6% sample." The success of these tests indicates that the "6% sample" may be used to estimate livestock numbers with a satisfactory degree of dependability.

**The Effect of Public Regulation of Milk Marketing Upon the Organization of the Milksheds of Massachusetts Markets.** (A. A. Brown, Elaine M. Roberson, and Judith E. Rosenthal.) The objective under this project has been to develop a satisfactory series of market data for the five principal secondary milk markets for the State. Comparable and reliable price series concerning the decade since the beginning of public control are now available for these markets. Milkshed maps have been prepared for each market. Bulletins have been published covering Springfield and Worcester.

**A Study of Farm Real Estate Taxation, Methods of Taxation Reform, and the Effect of Such Measures on Farm Income.** (A. A. Brown, Judith E. Rosenthal, and Elaine M. Roberson.) Statistical analysis of the tax and valuation data of the "10% sample" of dairy farms in Massachusetts has been completed. The results obtained from the compilation and analysis of data indicate excessive variation in assessment, which is fully as great among farms within a town as it is among the various taxing units. An analysis of the number of farms with more than one parcel of land, and the average number of parcels per farm show just how confused the assessment picture must be. For the entire sample, 61 percent of all the farms have more than one deed, while the average (number of farms) for the counties ranges from 39 to 94 percent. The average number of parcels per farm is 3.04. Statistically speaking, then, each farm is legally composed of three distinct units, requiring separate valuation, although from the *appraisal point of view*, good procedure might dictate either an over-all estimate

or a breakdown on a different basis. The figures obtained from one farm in an eastern county present this problem of variation rather dramatically. On this farm, one parcel of land is valued at \$13,000 per acre, and another at \$8 per acre!

In addition to the above, results indicate the following. There is an inverse relationship between real estate tax dollars per acre and the size of the farm by county averages. (However, this correlation does not take into consideration variations in types of land, said data being unavailable.) The average real estate tax for the whole sample is \$211.54 with extremes of \$26 and \$1128. There is a very marked positive skew to the farm size data distribution. One half of all the farms have 84 acres or less, while the range in size for the whole sample is from 7 acres to 885 acres. An inverse relation was found between value per acre and farm size by county averages. Value per acre was \$24 for the whole sample with a range from \$2 to \$382; the range for county averages was from \$16 to \$41. As far as could be determined from the data available, there is no relation, inverse or otherwise, between valuation and tax rate. The modal class for house valuations was \$1000 through \$1499, while one half of all the farms had houses valued from \$200 through \$1617. The range in house valuation for the whole sample was \$15,800. Cow units equal 78 percent of total livestock units, while cow valuation represents 85 percent of total livestock valuation. There is a high modal concentration in the \$50 to \$64 value-per-grade-cow group with the wide range in value per cow of \$110. Real estate taxation and personal property taxation tend to move together; the average tax paid on personal property was 34 percent of the tax paid on real estate.

**Production Efficiency on Dairy Farms in Massachusetts.** (C. R. Creek.) According to farm management records, labor efficiency increased almost 20 percent in the ten years from 1934 to 1944 for the same 50 dairy farms, on the basis of productive work units per man. On these identical farms the milking herd increased from 20 to 26 cows, cropland increased by 8 acres and pasture by 15 acres, while the total labor force remained the same at 30 months of hired, family, and operator labor per farm. The most important factor in this greater efficiency of labor was the increase in labor-saving machinery on these farms. The number of farms with milking machines increased from 23 to 43 in these ten years and those with electrical milk coolers from 20 to 45. The farm work was mechanized with tractors on 40 farms in 1944 compared to 19 ten years earlier. Trucks were listed on 40 farms compared to 30 farms in 1934. The number of ensilage cutters on farms increased from 26 to 35, side delivery rakes from 6 to 21, and hay loaders from 6 to 23.

Milk production was also more efficient in 1944, with 365 more pounds of milk produced per cow on slightly less grain, hay, and silage. Milk production increased from 2.6 to 2.8 pounds for each pound of grain fed in these two years.

In the period of low prices in 1933-34 the cash farm cost of producing milk was about \$1.39 per hundredweight, the price received was \$2.27 per hundredweight, and net farm income was \$687 per farm. In the high price period of 1943-44 the cash farm cost of production was about \$2.34 per hundredweight, the price received was \$4.09 without the feed subsidy, and net farm income was \$2524 per farm for the same 50 farms. The margin of prices received over prices paid, was greater in the period of higher costs of production. The relationship between prices was the important factor in higher returns rather than the absolute prices or costs.

**Loan Performance on Low Income Farms in Massachusetts.** (C. R. Creek.) Another year of high prices and generally high crop yields enabled nine of sixteen active borrowers from the Farm Security Administration in the Connecticut

Valley area to repay their crop loans in full from the 1945 production of tobacco, potatoes, and onions. Only six of 23 borrowers with livestock and livestock-crop loans paid their loans in full in the past year. Livestock loans have a longer period for repayment while crop loans are generally for one year.

Loans have been repaid on 134 of the 202 farms for which loans were made. Loans were defaulted on 5 percent of the farms and 13 percent are now classified as collection cases since these borrowers are no longer engaged in farming. Only 15 percent of the total number of farms since 1936 are now considered as active cases and less than one-half of these received supplementary loans in 1946. New loans in 1945-46 were chiefly to start potato growing and poultry farming.

Generally the cash-crop farms have shown a higher rate of repayment of loans and a lower proportion of collection and defaulted loans. The highly profitable tobacco and potato crops of the past three years have furnished income to pay off old debts and provided a surplus to finance farm operations for another season. Borrowers on livestock farms generally have met scheduled payments, but few have made advance payments on their obligations.

**Methods and Costs of Improving Land on Massachusetts Farms.** (C. R. Creek and J. F. Hauck.) The cost of boulder removal from crop and pasture land on Massachusetts farms varied from \$40 to \$100 per acre for the bulldozer charge under normal conditions. Some records have shown a cost of \$175 per acre for boulder removal where a small bulldozer was used and many large boulders were pushed out. On cropland where scattered large boulders were removed the cost was about \$35 per acre in one instance where 55 boulders were removed from 2.5 acres. Costs were generally less per acre where larger bulldozers were used, although the rate per hour was greater.

Costs of removing stone walls from farms ranged from 25 to 50 cents per linear foot under normal conditions, according to records obtained in 1945. Costs were highest where the stones were loaded on trucks with a gas shovel and hauled to a swamp for disposal. The cost was less where a trench was dug with a gas shovel and a bulldozer used to push the walls into the trench and cover the stones to a depth of three feet with soil. Costs were lowest where a wide and shallow trench was made with a bulldozer, the stones pushed in and spread over an area about eight feet wide and then covered with one to two feet of soil to make a dry roadway through orchards or pastures.

It is difficult to justify the removal of boulders and stone walls in order to have larger, more open fields for the use of labor-saving machinery, although many farmers contend that the cost will be repaid in seven to ten years in the lower cost of production which will result from mechanization of crop production.

A method of land improvement which has increased greatly in recent months is the blasting of drainage ditches by the Soil Conservation Districts. Although soil conditions vary between farms, the cost of dynamiting has ranged from 8 to 15 cents per linear foot for a ditch two to three feet deep and five to seven feet wide. This size of ditch with the natural slope of the land will drain many marsh and swamp areas to increase the acreage of pasture and hay land on farms. In some areas the main drainage system will be dug with a shovel or dragline through the cooperation of the Soil Conservation District and lateral ditches will be constructed by each farmer on his farm. Cooperative effort is necessary in most instances to obtain a suitable outlet for drainage ditches.

**Methods and Costs of Harvesting Hay on Massachusetts Farms.** (C. R. Creek.) Buck rakes mounted on a heavy car or truck chassis are an efficient means of harvesting hay when the distance from field to barn is not over one-fourth mile. The weight of load ranged from 500 to 800 pounds for these buck



rakes and the hay was loaded from both the swath and windrow in various instances. Buck rakes are most satisfactory on small farms with near-by hay fields and on farms with a small labor force for hay harvesting.

On many farms the labor-saving possibilities of the pick-up baler for hay have not been developed into an efficient method of hay harvesting. On most farms the bales are dropped on the ground in the field and must be loaded on a wagon or truck by hand. At the barn the bales are unloaded by hand, lifted into the mow and carried to final storage space. This method was costly, inefficient, and fatiguing for these larger farms where field balers were used.

On one fairly large farm with a 50-cow herd and a total of 75 animal units, the job of harvesting hay was made very efficient and non-fatiguing by using other equipment with the field baler. A one-man baler was used in the field with a low-wheel, rubber-tired wagon attached to the baler so that the bales were loaded directly on the wagon from a ramp built on the baler. A small tractor was used to haul the loaded wagons to the barn where an elevator powered by an electric motor was used to unload bales into the barn. This elevator was mounted on a wagon chassis and could be moved to small doors cut in the side of the barn at 25-foot spaces so that bales were carried only a short distance in the barn mow. The haying operation was continuous on this farm since two low wagons were used. One was loaded at the rate of three bales per minute while the other was hauled to the barn, unloaded, and returned to the field in the same length of time. The crew of five men (two in the field, two at the barn, and one hauling) under normal conditions could bale, load, haul, unload, and store a load of 51 bales every 17 minutes. For a continuous operation this amounts to almost one ton of hay per man per hour with a minimum of effort.

## DEPARTMENT OF AGRONOMY

Walter S. Eisenmenger in Charge

**Evaluation of Additions of Sodium Nitrate and Ammonium Sulfate when Applied to the Soil during the Late Summer Preceding the Spring when Tobacco Is Planted.** (Walter S. Eisenmenger and Karol J. Kucinski.) It has been observed that tobacco grown after crops of corn, timothy, or clover frequently did not yield well, probably because of a deficiency of nitrogen at the time when certain organisms were active in decomposing fibrous tissue. Different amounts of nitrogen — 50, 100, 200, 300, and 500 pounds per acre of nitrogen in the form of sodium nitrate or ammonium sulfate — were applied to plots on which corn and grass had previously been grown, for the purpose of ascertaining to what degree this would prevent the usual bad effects of these crops on the succeeding crop of tobacco. The nitrogen was applied sufficiently early in the season to permit the warm weather to facilitate the action of decomposition agencies.

In general, the yield per acre and the quality of the tobacco increased with each increment of sodium nitrate applied to plots which had had a preceding crop of grass. These increases were larger where calcium carbonate was used as a supplement than where calcium sulfate was so used. Generally the plots on which grass was plowed under were better than the plots from which the grass was harvested as hay before plowing. No definite correlation could be established on the series of plots which had the calcium sulfate supplement and on which the hay was harvested before plowing.

No significant relationship was found in the yields or quality of tobacco grown on plots where mature corn had been plowed under in the fall. Both, however, were decidedly lower on the series of plots from which the corn had been harvested

before plowing and were poorest on plots on which corn was allowed to stand over winter before plowing. Where nitrogen had been added before plowing, there was considerable increase both in yield and in quality; but the deleterious effects of corn on tobacco may not be entirely alleviated by the use of nitrogen.

The yields of tobacco on the ammonium sulfate plots were greater than on the nitrate plots, but the quality of the tobacco was inferior.

**The Absorption of Chemical Elements by Food Plants.** (Walter S. Eisenmenger and Karol J. Kucinski.) The experiment was set up to compare the intake of elements when used singly and in pairs. The intake of calcium and magnesium was studied as well as the influence of the copper ion on the intake of magnesium and the movement of magnesium in the plant.

Magnesium added to the soil caused an increase of magnesium in the plants in all instances. When calcium was added to the soil, most of the plants studied contained more calcium but approximately a fourth showed no increase.

In water solutions copper ions lowered the transfer of magnesium. In the field this was not observed, probably because of the small amount of copper added (75 p.p.m.) and the buffer action of the soil. The change in the composition of seeds from plants under varied conditions of ion application was insignificant.

There seemed to be a tendency for the calcium content of plant tissue to be increased when copper was added to the soil. No explanation can be made of this unusual behavior.

The magnesium content and, to a lesser degree, the calcium content of foods and feeds can be increased by application of the salts of these elements to the soil. In the seedling stage, the transfer of magnesium from the seed and the water medium to the aerial portion of the plant was diminished by as small an amount of copper as one-half part per million.

**Magnesium Requirements of Certain Plants.** (Walter S. Eisenmenger and Karol J. Kucinski.) Work on this project included study of the relationship of seed plant development and the need of plants for magnesium, as well as the relation between intake of magnesium and the supply of the element in the soil. This part of the project was designed to ascertain whether plants which readily show signs of magnesium deficiency take up more or less magnesium when an ample supply is present in the soil than plants which do not show symptoms readily.

Plants vary greatly in their reaction to soils of low magnesium content, and plants of a lower order of development show the deficiency more quickly than plants of extremely high development. Thus the buttercup (*Ranunculus*), the mallows, geraniums, elms, anemones, buckwheat, rhubarb, cabbage, and tobacco always react to low magnesium soils; while plants like the asters, dandelions, sunflowers, ragweed, lamb's-quarters (*Chenopodium album*), pigweed (*Amaranthus retroflexus*), and the grasses do not show any symptoms of magnesium deficiency when grown on the "deficiency" plots. There are two conditions where the above does not hold. First, when plants have been changed by selection or plant breeding, there is no certainty that these species will react at all to soils of low magnesium content. Second, and less frequently, certain plants such as the portulaca and blackberry, for example, when grown in low magnesium soil show deficiency only in subnormal growth and not through chlorosis. Some plants, as the mallows and buttercups, normally take up comparatively little magnesium, and their magnesium content, compared with that of other plants, is low. There is evidence that such plants react more quickly to low magnesium soils.

The ability to recognize the plants which are not tolerant to low magnesium content of the soil would afford a chance to correct this condition when the need

arises; for it is in the *early* stages of growth that magnesium is required and applying salts of magnesium *after* the symptoms appear is generally much too late.

**Long-Time Fertility Tests.** (Karol J. Kucinski, Walter S. Eisenmenger.) Fifty to sixty years ago a series of test plots was established to study the effects on the soil and crops of a long-time fertilizer program. Where the plots were treated singly with either nitrogen, potash or phosphorus, the nitrogen plots showed the greatest response. Yields of hay ranged 2 to 2.5 times as great on plots receiving lime as on those not limed. Rabbits fed grass grown on limed plots made greater growth than rabbits fed grass grown on unlimed plots. Similar results were obtained where cabbage was used to feed the rabbits.

**Sunflowers and Their Possibilities.** (Karol J. Kucinski and Walter S. Eisenmenger.) Although the 1945 growing season was generally unfavorable for most farm crops because of abnormal rainfall, sunflowers did remarkably well. The Mennonite and Sunrise varieties, which are considerably shorter than the Mammoth Russian, yielded less seed, but this disadvantage was counteracted by less breakage of the stalks in wind storms. The wet season was very conducive to weeds, yet the sunflowers had no difficulty in shading out all weeds growing in the plots. Yield studies indicate that sunflowers will respond to liming. Heavy fertilization of soil of good fertility tends to produce abundant vegetative growth with the possible risk of lodging, especially during wind storms.

**Soil Conservation Research Projects.** (Karol J. Kucinski and Walter S. Eisenmenger.)

*Physical and Chemical Properties of Wind-Blown Soils.* Laboratory and field tests have been in progress for several years to determine why certain soils are subject to wind erosion while others are not. A specially constructed wind tunnel was used in the laboratory to supplement field observations.

Climatological data were studied to ascertain what elements of climate influenced dust storms as they occurred naturally in the Connecticut River Valley. It was found that rainfall has only a very small effect on retarding wind erosion; while the months of January and February, the period of greatest snowfall, usually have fewest dust storms. A direct relationship exists between known occurrence of dust storms and the monthly prevalence of winds, particularly those of over 10 miles per hour. The data show that wind velocities increase in the afternoon. This corresponds with the observation that nearly all dust storms occur in the afternoon.

In the comparison of the physical and chemical soil tests with wind tunnel studies, it was found that the more sandy the soil, the lower was the initial velocity at which it began to blow. The initial velocity was generally lower for frozen soils than for air-dried soils. For most of the soils studied, the losses were greater at low wind velocities for frozen soil than for air-dried soil; while at the higher wind velocities, the air-dried soils were more erodible. It was found that the organic matter content, the maximum water-holding capacity, the moisture equivalent, and the hygroscopic coefficient of the soil had a direct relationship to wind erosion. It was further noted that the higher the settling volume of a soil, the lower were its losses in the wind tunnel. A ripple or wave pattern appeared on the surface of sandy soils (non-agricultural) when blown in the wind tunnel, while agricultural soils showed streaks.

Soil moisture studies show that wet soil will not blow at any wind velocity. The very top thin layer of particles is relatively dry before it wind erodes, while sublayers of soil may be relatively moist. Sandy soils blow sooner after a rain because the capillary action is broken at the very surface of the sandy soil.



Dust collected showed 0.46 percent moisture, while the parent soil had a 26.0 percent moisture content.

Where the formation of aggregates in dry soils was increased by chemical treatment, their tendency to blow was decreased. Soils treated with ground limestone, burnt lime, urea, and lithium carbonate showed decreased losses with the treatments in the order mentioned; the finer the texture of the soil, the more pronounced the effect. Calcium and sodium silicates tended to bind the soil into aggregates and so reduced soil losses. Organic matter when applied in the form of raw lignin lowered the initial velocity at which the soils began to blow and also increased the rate of wind erosion. The lignin used was not comparable to soil humus or organic matter. The organic matter produced in a soil from the decomposition of yearly applications of sawdust reduced the amount of wind erosion and also raised the initial velocity at which the soil began to blow. Soil taken from under a manure pile dried into a coarse lumpy condition which was quite resistant to wind erosion.

A study of the deflocculating effects on the soil of the mono-valent elements in period one of the "Periodic Tables of Atoms" showed that, upon drying, the soils had experienced an aggregated condition which increased in the following order of the elements tried: lithium, sodium, potassium, rubidium. The pH value of the soils was greatly increased by this chemical treatment. The rate of increase of the pH values was in the reverse order to the aggregating effect.

To study the rate of wind erosion on fields of various crops and the relation of the cultural practices to dust blowing, a portable dust collector was developed. These studies show that the soil blows more on areas growing vegetables like onions and lettuce than on areas used to grow tobacco and potatoes. There was a direct relationship between pH and amount of dust collected. These observations were confirmed in the wind tunnel studies where soils from two experimental plots were tested. Soil from a plot having a yearly application of limestone had a pH of 6.9 and eroded considerably more than soil from a plot which had not received any lime and had a pH of 4.8. It is believed that the flocculating effect of continuous liming has produced a soil surface condition more susceptible to wind erosion.

*Use of Snow Fencing in Controlling Wind Erosion.* The results of this test, which was described in detail in the annual report of 1944-1945, were not very conclusive this year owing to the lack of dust storms during the exceptionally wet season of 1945. The anchorage of the snow fencing with iron pipes,  $4\frac{1}{2}$  to 5 feet long, driven 18 inches into the ground and spaced a rod apart, held the 4-foot-high lath fencing throughout the entire season. Frost action did not tend to heave the anchorage out of the ground.

**Black Root Rot of Tobacco.** (C. V. Kightlinger.) Strains of Havana Seed tobacco that yield well under black root rot promoting conditions often produce tobacco that is not fully acceptable to all of the tobacco trade when grown under favorable producing conditions. Therefore an attempt is being made to breed strains which will produce tobacco of acceptable type and quality in profitable amounts under both these growing conditions.

Havana K1 and Havana K2 and other new strains thus far produced are now being grown commercially to ascertain their suitability for general use in the Connecticut Valley. These strains yield well under different growing conditions; and so far, the tobacco produced seems to be receiving greater approval for type and quality by the tobacco trade than that produced by Havana 211 and other previously produced strains. It is too soon, however, to know whether these new strains will be entirely satisfactory.

Meanwhile, work is being done to effect further improvements: first, by selecting the most desirable plants within the strains already produced to improve habits of growth as well as type and quality; and second, by breeding entirely new strains.

**Brown Root Rot of Tobacco.** (C. V. Kightlinger.) Ordinarily, but not always, tobacco grown immediately following corn, grasses, and a few other crops develops brown root rot in some degree, in the Connecticut Valley. It is probable that more than one factor may be responsible for this irregular occurrence of the disease; but it is natural to suppose that soil fertility may be one of the most important. With this in mind, experimental work is now in progress, as follows:

1. Crops known to produce brown root rot promoting soil conditions under usual fertilizing practices are being grown with more than the usual amounts of fertilizer, to determine what effect this will have on the following crop of tobacco. Results are not yet available.

2. Different amounts of fertilizer are being used on tobacco following crops known to produce brown root rot promoting soil conditions, to determine whether fertilizer can be so used as to prevent the development of the disease following these crops. Results are not yet available.

3. Tobacco is being grown continuously on the same land, with inadequate fertilization, to ascertain whether the disease will develop under these conditions. It has been definitely determined experimentally that brown root rot will develop, in moderate degree at least, on tobacco that is grown continuously on the same land under certain inadequate fertility conditions. This result, in connection with the well-known fact that brown root rot may be overcome, in the Connecticut Valley at least, by growing tobacco continuously on brown root rot promoting land for three or four years under usual tobacco fertilizing practices, suggests that malnutrition may be important in the development of the disease. Further tests are necessary.

**Control Measures for Mildew of Tobacco.** (C. V. Kightlinger.) In experimental work to test the comparative effectiveness of different materials in the control of mildew of tobacco in seedbeds, Fermate and bismuth subsalicylate used in recommended concentrations gave complete control of the disease in 1946. Mildew developed in moderate severity in the untreated check. The materials were applied at weekly intervals with sprayer at 150 pounds pressure. Eight applications were made throughout the season, beginning May 3, before any cases of mildew in tobacco seedbeds had been reported.

**Potato Seed Treatments.** (C. V. Kightlinger and H. M. Yegian.) Seed potatoes of seven varieties grown regularly in the State (Chippewa, Katahdin, Earleine, Sebago, Irish Cobbler, Green Mountain, and Russet Rural) were treated with cold mercuric chloride plus acid, cold formaldehyde plus acid, Semesan Bel, Sanoseed, Fermate, and Spergon, to ascertain the relative tolerance of the varieties to disinfecting treatments and the comparative effectiveness of the treatments in the control of scab and rhizoctoniosis.

Mercuric chloride and formaldehyde caused little injury to tubers of the Irish Cobbler, Green Mountain, and Russet Rural varieties; moderate injury to tubers of the Katahdin, Earleine, and Sebago varieties; and more severe injury to tubers of the Chippewa variety. These treatments caused reductions in stands of potatoes in the field ranging from slight, in the case of Irish Cobbler, Green Mountain, and Russet Rural; moderate to heavy in case of Katahdin, Earleine, and Sebago; and severe in the case of Chippewa. Semesan Bel, Sanoseed, Fermate, and Spergon caused no noticeable injury to the tubers of any of the varieties before planting; but Semesan Bel and Sanoseed had some detrimental effects on

the stands of Katahdin, Earleine, and Sebago, and worse effects on the stands of Chippewa.

None of the seed treatments seemed to increase the vigor of plants. Careful examination of growing plants and later inspection of mature tubers after digging, showed no consistent differences in the amounts of rhizoctoniose on potatoes grown from treated and untreated seed. No scab developed in any of the plots, not even in the control grown from untreated seed.

On the basis of experimental results obtained in 1945 as well as the two previous seasons, disinfecting seed treatments are of doubtful value as control measures for rhizoctoniose of potatoes in most potato land. Although no scab developed even in the control plots, it is reasonable to believe that disinfecting seed treatments would be of doubtful value in the control of scab also.

**Evaluation of New Lines of Irish Potatoes for Resistance to Scab and Rhizoctoniose.** (C. V. Kightlinger and H. M. Yegian.) Newly developed lines of Irish potatoes were tested for comparative resistance to scab and rhizoctoniose in informal cooperation with the Division of Fruit and Vegetable Crops and Diseases of the United States Department of Agriculture.

Several of the new lines were apparently highly resistant to scab. A few of the lines showed no traces of scab when the Green Mountain control scabbed so badly that its tubers were utterly worthless. A few of the lines showed evidence of having considerable resistance to rhizoctoniose. Other lines bore enough small sclerotia on their tubers to interfere greatly in estimating the comparative scab resistance of the lines. There were not enough plants to spare any for examination in the growing stage to ascertain their resistance to rhizoctoniose more completely. More information about the comparative resistance of these lines to rhizoctoniose is needed.

**Potato Variety Trials.** (Karol J. Kucinski, Ralph W. Donaldson, Walter S. Eisenmenger.) Because the 1945 growing season was abnormally wet, the yields obtained in the potato variety test were much lower than in former years, ranging from 273 bushels per acre for Sebago to 107 bushels for 47102 Teton.

Based on yields of marketable size, the ranking of potato varieties in the Experiment Station plots during the season of 1945 was Sebago, Cayuga, 055, Red Warba, 627-103, Green Mountain, Mohawk, Chippewa, Pawnee, Katahdin, 46952, Cobbler, Houma, Russet Rural and 47102 Teton.

**Corn Improvement Program.** (Hrant M. Yegian.) Seventy-five varieties, mostly hybrid seed corn supplied by state experiment stations and private seed companies were tested for their general adaptability and yield. In the early maturity group, Wis. 412A and Mass. 62 produced the highest yield of shelled corn per acre (90 bushels). Wis. 643 was the highest producing full-season silage corn. The very late maturing varieties produced somewhat more silage per acre, but this consisted mostly of stalks and leaves. Therefore, the quality and feeding value of the silage would not be as high, pound for pound, as that from varieties which produce a higher proportion of ears which are in the dough or pre-dent stage before the killing frost. With somewhat earlier maturity it is possible to ensile before the usual mid-September frost or hurricanes which do great damage to silage corn. The results of the 1945 field tests are published in mimeographed form and are available upon request.

Fifty-five single crosses involving all possible combinations of eleven inbred lines in the early maturity group were tested. On the basis of this test, a few of the promising predicted double crosses were made in the greenhouse during the winter and these are being tested in the field during the 1946 season. The double cross (CC4xCC8) x (Q83xA96) promises to be an especially good, early-maturing field corn.



Among the thirty-six experimental double crosses there were two especially good mid-season hybrids. These are being tested further prior to their release to the farmers.

The results of yield tests on three rates of planting on three different dates were not very reliable. Excessive rainfall in the spring and poor drainage of the field where the test was carried on caused wide discrepancies among the replicates.

A set of fifty-five early maturing single crosses was made here last year in cooperation with the northeastern corn breeding program. These are being tested for their general adaptability in the northeastern region.

**Onion Breeding.** (Hrant M. Yegian.) In 1945 a number of male-sterile Early Yellow Globe and Ebenezer crosses supplied by Dr. H. A. Jones of the United States Department of Agriculture were tested. Some of this material was very promising, particularly one backcross which made a vigorous growth, was of nonbolting globe type, and had exceptionally uniform skin color and bulb shape. A number of bulbs of male-sterile lines have been planted in isolated plots and are being pollinated with selected strains of Ebenezer lines in order to determine the relative combining ability of the various strains and lines used. The resulting hybrids will be tested to ascertain their adaptability in the Connecticut Valley.

Preliminary evidence tends to show that application of borax at the rate of 30 to 50 pounds per acre on set-producing fields may have subsequent beneficial effect on the keeping quality of the stored onions. Most onion soils have a pH value of 6.0 to 6.5, which is maintained by the application of one to two tons of limestone per acre, every two or three years. Since boron starvation occurs more frequently on heavily limed soils than on acid soils, it seems advisable to apply sufficient borax to safeguard against this difficulty.

Various fungicidal chemicals, Fermate, Puratized N 5 E, Isothan Z-15, Wettable No. 604, Wetttable Spergon, and Dithane D 14, were tested for the control of storage rot of onions. Preharvest spraying of plants—three applications at weekly intervals prior to pulling—dipping the bulbs from unsprayed plants, soon after they were harvested, in concentrations recommended by the manufacturers of these chemicals, did not give any control of rot in storage. The best and most weekly intervals prior to pulling—or dipping the bulbs from unsprayed plants, soon after they are harvested, in concentrations recommended by the manufacturers of these chemicals, did not give any control of rot in storage. The most practical method known for reducing losses in storage is to store only sound onions in cold storage under controlled conditions at 32°-35° F. and low humidity.

**Pasture Renovation Experiments.** (Wm. G. Colby.) Work was begun in 1943 in cooperation with the U. S. Department of Agriculture Regional Pasture Laboratory in State College, Pennsylvania, for the purpose of studying practical methods of renovating depleted or "runout" pasture land by tilling, fertilizing, and reseeding. Experiments were laid out on fields which differed widely in topography, character of native vegetation, degree and nature of stoniness, and soil drainage relationships. This was done intentionally; for, as the work progressed, it became increasingly obvious that different conditions may require widely varying methods of procedure to secure the most effective results. Following is a summary of some of the observations which have been made during the course of these experiments.

**Degree of Stoniness.** It is doubtful whether attempts should be made to renovate stony land until most of the surface stones, six inches in diameter or larger, have been removed. If many stones of this size or larger are exposed, it is extremely difficult to work up a seedbed. If a bog harrow is used, for example, the machine tends to bounce from rock to rock and in so doing loses much of its effectiveness as a tillage instrument. Repeated working of the land is necessary to secure a satisfactory seedbed. Excessive wear is caused not only on the harrow but on all other machines which may be used.

*Stone Removal.* In the hands of an experienced operator a large caterpillar tractor with regular bulldozer attachment is probably the most efficient and practical means of removing large stones. Rocks weighing from a few hundred pounds up to several tons can be removed in the course of a few minutes. A bulldozer was also found to be useful in leveling off uneven "hummocky" land by dragging the blade and operating the machine in reverse. This breaks down the hummocks and tends to tear them apart.

The removal of smaller stones is a more difficult problem. There seems to be no other way except to pick them up by hand, and this is a slow, arduous operation. If there is grass growing, many stones become so imbedded in the sod that the use of a bar is necessary to pry each one loose. A preliminary disking with a bog harrow after the large stones and boulders have been removed will help to dislodge many of the smaller stones and thereby facilitate their removal.

*Character of Native Vegetation.* The effectiveness of different tillage implements is greatly influenced by the nature and quantity of native vegetation.

1. *Moss cinquefoil association:* a bog harrow is particularly effective in destroying this type of cover. One thorough disking is usually sufficient.

2. *Grass sod:* The destruction of a grass sod can be accomplished with a bog harrow, but several diskings are usually required. So far, disking at intervals of one to two weeks during midsummer has been the most effective means of destroying bluegrass and bentgrass sods. If operations are begun in July, a satisfactory seedbed can usually be prepared for seeding in late August. If seeding is delayed until the following spring, there may be considerable recovery of the native grasses.

3. *Herbaceous woody plants (hardhack, meadow sweet, ground pine, laurel, etc.):* If the proportion of woody plants is high, a bog harrow is not particularly effective unless most of the native growths are first mowed and removed. The mowing operation, too, is most successful if carried out in midsummer. Where the land is not too stony or rough, a brush-breaker plow can be used satisfactorily, in which case mowing the native vegetation may not be necessary.

*Time of Seeding.* Thus far late-summer seedings have been much more successful than spring seedings. This may have been partly due to the abnormally warm weather early in the spring of 1944 and again in 1945 which was unfavorable to new seedings. Probably more important than unusual weather conditions, however, were the difficulties encountered in preparing a well-consolidated seedbed with so much undecomposed plant material present. These soils tended to dry out more quickly than regularly cultivated soil until some of this raw organic matter had broken down. It was observed that dry weather following spring seedings was more damaging than dry weather following fall seedings.

*Studies on the Causes of Winter Injury to Ladino Clover.* (Wm. G. Colby.) Although most stands of Ladino clover show evidences of winterkilling every spring, injury is much more severe after some winters than after others. In the summer of 1943 a field experiment was laid out with the objective of studying some of the factors associated with this trouble. Seedings were made of Ladino clover alone and in combination with orchard grass (S 143), smooth brome grass (northern strain), meadow fescue (Svalof Early), and timothy. Different cultural treatments were also included.

It was not until the spring of 1946, when Ladino clover stands generally suffered extensive winter injury, that significant differences between treatments were evident. The plots which were mulched with straw showed no injury

whatsoever. The straw had been applied on November 16 at the rate of  $3\frac{1}{2}$  tons per acre and removed the following April just before active spring growth started. The clover in all other plots (with the exception of part of one manure plot which accidentally received a very heavy application of cow manure) was severely injured. On this one small section, the manure application was so heavy that it actually served as a good mulch. Where cow manure was applied at a lighter rate (10 tons to the acre), winter injury was severe.

The Ladino clover in all plots appeared to be vigorous and healthy at the time the manure and straw mulch applications were made in November. Since all plots were covered with snow a few days later, it seems probable that most of the injury occurred in early spring after the snow had melted. There were several days during the latter part of February and the first part of March when winds of record or near record velocity were experienced. It is suggested that much of the winter injury to Ladino clover is actually spring injury occurring after the snow melts, and is caused by the drying action of heavy spring winds on the fleshy Ladino stolons.

**Trials with New Oat Varieties.** (W. G. Colby.) Heavy summer thunder showers caused serious lodging in many varieties included in the oat variety test carried on in cooperation with the U. S. D. A. Division of Cereal Crops. The varieties Vicland and Tama, which had given high grain yields in previous years, lodged badly and yielded only 47 and 43 bushels per acre respectively. Clinton and a new variety, Mindo, both of which matured about the same time as Vicland, lodged only slightly and yielded 83 and 79 bushels per acre. Ajax and Benton varieties, which matured about five days later than Vicland, produced yields of 84 and 80 bushels per acre.

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## DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

**A Study of the Mineral Elements of Cows' Milk.** (J. G. Archibald.) As a result of extensive study of methods for the determination of cobalt in milk, in which Dr. Beeson of the U.S.D.A. Regional Laboratory at Cornell University collaborated, it was decided last summer that further progress could not be made with existing laboratory facilities. A room has, therefore, been remodeled and re-equipped for this and other special "trace" element work, and active work on the project is being resumed.

**The Effect of Feeding Synthetic Thyroprotein to Milking Cows.** (J. G. Archibald.) Results for the winter season of 1944-45 have been published.<sup>1</sup> The work reported was mainly a study of the effects of the hormone on milk composition. The most important effect was a considerable and rather consistent decrease in casein, and a roughly proportional increase in lactalbumin and globulin. Changes in fat content of the milk were not consistent.

Since these changes may be of considerable significance if characteristic of the action of the hormone on cows in general, it was thought advisable to repeat the work in a more intensive manner. This was done in the winter of 1945-46, with a smaller number of cows (6) but using the same individuals throughout and trebling the number of milk samples taken. This later work is in general agreement with the earlier results: the effect of the hormone on milk composition was not consistent, but the tendency for the casein of the milk to be decreased was

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<sup>1</sup>Journal of Dairy Science, Vol. 28, No. 12, pp. 941-947, December 1945.



still apparent. Individual cows, even within a breed, varied widely in their response to the hormone stimulus. Holstein cows in general were less responsive than Ayrshires, Guernseys, or Jerseys. Live weight decreased sharply at first, but after a few weeks increased slowly, even while the hormone was still being fed. Respiration and pulse rates in general were accelerated somewhat, but individual animals showed great variations in these respects.

**The Effect of Massive Doses of Irradiated Yeast on Incidence of Milk Fever in Dairy Cows.** (J. G. Archibald.) This project is a part of a more comprehensive one, the other phases of which were terminated several years ago. This particular phase has been kept active but data have been slow in accumulating because of the limited number of cows (6) in the college herd suitable for the study; that is, having a previous history of milk fever.

The procedure consists in feeding one mullion units of vitamin D in irradiated yeast daily per cow for one month previous to calving. As indicated above the yeast was fed only to cows having had milk fever previously. In five out of the six cases, cows receiving irradiated yeast did not develop milk fever; also, when used as controls in a subsequent lactation (that is, not fed the yeast), two out of three of these cows did have milk fever again. A fourth cow, not intended as a control but refusing the grain with which the yeast was mixed, makes it three out of four cases in this latter category. Especially worthy of note is the case of one cow which responded to the yeast feeding in two successive lactations, but reverted to her original status when used later as a control.

Further cases will be studied before final conclusions are drawn; but so far as these cows are concerned, the treatment appears to have been a definite value.

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## DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

**Bacteriological Studies of Rural Water Supplies.** (James E. Fuller.) This study was a comparative differentiation of coliform bacteria from privately owned rural water supplies at several temperatures: 37° C., as provided by the Standard Methods of Water Analysis of the American Public Health Association; 44° C., as employed by the British practice; and 46° C., as employed in the Eijkman test. To provide an intermediate temperature between A.P.H.A. Standard Methods and the British system, 40° C. was also employed in the study. The tests employed were the indole, methyl-red, Voges-Proskauer, and sodium citrate tests, as directed in the A.P.H.A. Standard Methods. The results warrant the recommendation that the methyl-red test at 44° C. be employed for effective differentiation of sewage-type (fecal) coliform bacteria from surface-wash (soil-type) coliform bacteria in the testing of raw waters from wells, springs, and streams. The study has been completed and results published.<sup>1</sup>

**Relation of Chloramine-resistant Bacteria to Milk Supplies.** (James E. Fuller.) The isolation and study of bacteria surviving chloramine treatment in a public water supply have been reported and published.<sup>2</sup> Since the supply in question, the others like it, serve milk-bottling plants and some dairy farms, it appeared to be desirable to determine the effect of these bacteria on milk supplies. Results indicate that all of the bacterial cultures isolated were capable of

<sup>1</sup> Journal of Bacteriology, Vol. 51, No. 4, pp. 457-464, April 1946.

<sup>2</sup> Journal New England Water Works Association, Vol. 58, No. 2, pp. 89-100, June 1944; and Vol. 59, No. 3, pp. 244-251, September 1945.

multiplying in milk and spoiling it, even at the normal operating temperature of an electric refrigerator. All of the cultures were killed effectively by pasteurization except those that formed spores. These was as expected. This project is completed.

**Study of Septic Tank Efficiency.** (James E. Fuller.) In this study three septic tanks of identical size were supplied with sewage from one of the college dormitories. The rates of supply to the three tanks were so regulated that sewage was retained in them 24 hours, as usually recommended, 12 hours, and 8 hours, respectively. The object was to determine whether the shorter retention periods would result in greater operating efficiency in the tanks. Results showed that the conventional 24-hour retention was superior to the shorter periods on the basis of the following evidence: (1) the coliform index of the effluent was lower for the 24-hour period than for the shorter periods; (2) the biochemical oxygen demand results favored the 24-hour period as compared with the shorter periods; (3) at the end of three months of operation for two consecutive seasons, the thickness of scum in the normal tank was about 2 inches; while in the tanks with 12-hour and 8-hour retention periods, thicknesses of 11 and 13 inches respectively resulted, which would have plugged up the outlets of these tanks if they had been constructed with the usual outlets. An extension of the project was secured to permit a study of the permeation of coliform bacteria into the soil of the disposal field, and of the accumulation of nitrates in the soil. This work is in progress now.

**Effectiveness of Commercial Surface-active Agents for Use as Household Cleansing Agents.** (James E. Fuller.) Some 42 agents have been examined to determine their germicidal power. About one-third of them were found to be very effective, and several others were moderately effective. Experiments are now under way to devise a procedure for evaluating the efficiency of these agents on a sliding scale on the basis of variations of time and concentration, preparatory to investigating the effect of organic matter, acids, and alkalis on the germicidal power of the agents.

**Types of Microorganisms Involved in the Spoilage of Home-canned Foods.** (Ralph L. France.) This is a new project an work has only been begun. To date no results are available for report.

**Laboratory Service, July 1, 1945, to June 30, 1946.** (James E. Fuller.)

Milk samples, bacteria counts.....	171
Ice cream samples, bacteria counts.....	76
Water samples, bacteriological tests.....	140
Total.....	387

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## DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

**Diseases of Trees in Massachusetts.** (M. A. McKenzie and A. Vincent Osmun.)

*The Dutch Elm Disease Problem.* As of July 1, 1946, the Dutch elm disease, caused by the fungus *Ceratostomella ulmi* (Schwarz) Buisman, has been isolated from 182 trees in 28 municipalities in Massachusetts, as follows:

	1941	1942	1943	1944	1945	1946	Totals
<b>Berkshire County</b>							
Alford.....	1			2		4	7
Dalton.....					1		1
Egremont.....		3	2	3		1	9
Great Barrington.....		1	1	6	6	13	27
Hancock.....					1		1
Lanesboro.....						1	1
Lenox.....					2	1	3
Mount Washington.....				1			1
New Marlborough.....						17	17
Pittsfield.....				3	5	2	10
Richmond.....					9	8	17
Sandisfield.....				1			1
Sheffield.....		1		5	2	13	21
Stockbridge.....				2		12	14
West Stockbridge.....			1		1	11	13
Williamstown.....					1		1
<b>Hampden County</b>							
Agawam.....					1		1
Chicopee.....						2	2
East Longmeadow.....					1		1
Holyoke.....				2	1		3
Longmeadow.....				1	5	6	12
Southwick.....				2			2
Springfield.....				2	3	5	10
Westfield.....		1			1		2
West Springfield.....				2			2
<b>Hampshire County</b>							
Granby.....						1	1
Middlefield.....					1		1
South Hadley.....					1		1
<b>Totals.....</b>	<b>1</b>	<b>6</b>	<b>4</b>	<b>32</b>	<b>42</b>	<b>97</b>	<b>182</b>

Symptoms of the disease include wilting, curling, yellowing, early falling of leaves, and brown streaking of fungus-infected wood. Affected trees die suddenly or gradually. Elm bark beetles serve as carriers of the causal fungus. Adult beetles penetrate between the wood and inner bark of weakened trees and engrave breeding galleries. Later the young emerge to feed on tender small twigs and in so doing may inoculate trees if the fungus was carried from breeding galleries by beetles.

The spread of the disease during the past five years has borne out previous experimental work and observations that the incidence of disease tends to build up where conditions are most favorable for increase in population of carrier beetles. Thus far relatively few valuable elms in Massachusetts have been killed by the disease; but if the spread among weed elms is left unchecked, additional important losses may be expected.

Interest and cooperation in control of the disease throughout the State is encouraging. The timely application of appropriate disease control measures may materially check the spread of the disease.



1. Destroy all elms affected by Dutch elm disease.
2. Remove and burn promptly bark from any cut elm wood.
3. Avoid piling elm wood in the open unless it is peeled.
4. Don't transport elm wood with bark attached.
5. Spray elms to control leaf-eating insects.
6. Keep elms as healthy as possible.

Additional methods of disease control are being explored, and in cooperation with the Department of Entomology the uses of spray materials for control of carrier-insects are under investigation.

*Other Tree Problems.* Fifty-three diseases of twenty-seven species of trees including nine diseases of elm were identified from approximately 400 specimens and inquiries received during the year. The *Cephalosporium* wilt of elm was reported from three additional municipalities in Massachusetts. *Verticillium* sp. was isolated from several species of woody plants.

During the year, postwar planning of municipal tree programs was rapidly accelerated. The most conspicuous and obvious need is treatment of injuries and defects neglected for five years because of man-power shortages. Trees found to be in such condition as to endanger the public should be removed, pruned, or strengthened to eliminate hazards. In many communities a good start has been made on constructive tree protection programs which should help limit the spread of leaf diseases.

The occurrence of broken tree limbs this year has resulted in numerous inquiries. Wind and rain storms have caused considerable damage of this type. Also, in the course of reconverting housing and industrial activities for postwar needs, there has been considerable cartage of relatively large, partly assembled construction units throughout the State. The movement of such material is ordinarily not sufficient to cause extensive breakage of roadside trees. However, currently, extensive tree breakage is traceable to this source as well as to the increasing movement of heavy road-construction machinery along highways.

**Diseases of Plants Caused by Soil-infesting Organisms, with Particular Attention to Control Measures.** (W. L. Doran.) It was found that, in the absence of fungicides, damping-off is much less severe if soils having a moisture content of about 30 percent of the water-holding capacity at the time of seeding are not watered for the first time until four or five days thereafter.<sup>1</sup>

The use of fertilizers as carriers of soil fungicides, especially for the control of damping-off, cabbage club-root, and soil-borne onion diseases, was further investigated. Organic fungicides used in this or the following project, and hereafter referred to by the trade names only, include tetramethyl-thiuram-disulfide (Arasan, Thiosan, and Tuads); 2, 3-dichloro-1, 4-naphthoquinone (Phygon); tetrachloro-parabenzoquinone (Spergon); disodium ethylene bisdithiocarbamate (Dithane D 14); ferric dimethyldithiocarbamate (Fermate); hydroxymercurichlorophenol (Semesan); and zinc salt of 2, 4-trichlorophenol (Dow Seed Protectant No. 9.)

Mercury salts, 0.2 gm. per square foot, applied to soil in the fertilizer, a 5-8-7 formula, did not control club-root of cabbage in the soils used as well as did hydrated lime. Best results on the basis of disease control and growth of plants were secured with pyridylmercurichloride or ethyl mercury phosphate used in a limed soil.

<sup>1</sup>The writer read a paper on "Control of Damping-off by a Delay in First Watering after Seeding" at the December 1945 meeting of the American Phytopathological Society. An abstract will appear in an early number of Phytopathology.

Fermate, applied to the soil in and with fertilizer, successfully controlled onion smut.<sup>2</sup>

More recent work with onions has involved principally a study of the prevention of pink root-rot of onion, caused by *Fusarium*, by treatments of soil or sets with fungicides. Yields of onions, from seed, in pink root-rot infested soil were increased 48.9 percent by Thiosan, 70 pounds per acre; 36.9 percent by Fermate, 70 pounds per acre; and 23.3 percent by Fermate, 50 pounds per acre. Treatments of onion sets with Arasan, Fermate, or Spergon failed to lessen the severity of pink root-rot.

Dithane 2.5 cc., Tuads 0.6 gm., or Phygon 0.45 gm. (per square foot in all cases), applied in fertilizer to soil infested with *Pythium*, markedly improved the stands of onion, cabbage, tomato, and beet, and there was no chemical injury when seeds were sown immediately after soil treatment. Similarly used, Tuads also gave good results with pepper, Phygon with pea, Dithane with cress, and Dow Seed Protectant No. 9 (0.45 gm. per square foot) with cabbage, beet, and cucumber. The last named fungicide, however, was injurious to pea, onion, pepper, and tomato in some soils. The use of fertilizer as a carrier for a soil fungicide is simple and appears promising; and it should be noted that applications of 0.6 or 0.45 gm. per square foot are only about 57.6 or 43.2 pounds per acre.

Seed treatments and several standard soil treatments for the control of pre-emergence damping-off of *Lilium regale* were compared. The disease was best controlled by seed treatment with Thiosan, Arasan, or Semesan. Spergon or Fermate similarly used gave inferior results and so did the several soil treatments.

**Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment.** (W. L. Doran.) The hemlock, *Tsuga canadensis* (L.) Carr., is highly variable and there are indications of increasing demand for some of the better clones, a demand which will exceed the present supply. Work on their vegetative propagation was accordingly begun. Different clones were found to respond very differently to the same treatments, rooting of cuttings from some, not from others, being improved by treatment with indolebutyric acid 200 mg./l., 8 hours, or 100 mg./l., 6 hr., with powder dips less effective. Rooting of cuttings of hemlock, taken in October and November, was not improved by supplementary treatment with the fungicide Arasan<sup>1</sup> applied after treatment of the cuttings with a root-inducing substance.

The effects of root-inducing substances and fungicides applied together to the cuttings of several conifers and of American holly was also investigated. Cuttings of holly rooted in larger percentages after treatment with indolebutyric acid alone (100 mg./l., 20 hours) than they did if that treatment was followed by treatment with Fermate or Spergon.

A root-inducing treatment which was applied with benefit to cuttings of holly taken in October was apparently injurious to cuttings taken in January.

As a carrier of indolebutyric acid applied as a powder-dip, Spergon caused some injury to cuttings of Norway spruce, but Fermate or Arasan caused no injury.

Rooting of cuttings of hemlock, American arbor-vitae, and Chinese juniper was improved by treatment with indolebutyric acid 4 or 8 mg./gm. Fermate.

Some work was done on vegetative propagation of the Kudzu vine, *Pueraria Thunbergiana* (Sieb. and Zucc.) Benth., interest in which, both as a forage crop

<sup>2</sup>The abstract of a paper by W. L. Doran and T. Sproston, Jr., on "The Control of Onion Smut by Fungicides Applied to the Soil" was published in *Phytopathology* 35:8:654. 1945.

<sup>1</sup>The active ingredients of this and the other fungicides mentioned are named in the report on the preceding project.

and for soil conservation, is increasing. One-node cuttings responded well to powder-dip treatment with indolebutyric acid, but many cuttings died after rooting if taken as late as September.

In work with the Department of Pomology on the propagation of apple dwarfing stocks, cuttings of Malling No. 4 rooted well if taken in early May and given powder-dip treatment with indolebutyric acid.

Observations on the subsequent growth of rooted cuttings of white pine were continued in the field. They appear to be developing into normal, well-formed young trees.<sup>2</sup>

Surface watering was compared with subirrigation as factors affecting rooting of cuttings of conifers. Cuttings of hemlock, Hinoki cypress, two species of fir, and two species of spruce taken in November rooted better in sand watered from above than in sand subirrigated.

Work on the propagation of the rose by cuttings, initiated at the request of florists who could not obtain grafting stock, was concluded and results published.<sup>3</sup>

**Tomato Leaf Mold Caused by the Fungus, *Cladosporium fulvum* Cke.** (E. F. Guba, Waltham.) Four tomatoes resistant to leaf mold were developed to desirable commercial type and released for commercial trial for the fall growing season of 1945. These types were designated Improved Bay State, Improved Vetomold-121, Leafmold Resistant Marglobe, and Leaf Mold Resistant Waltham Forcing. Resistance to the fungus was derived from Plant Introduction No. 112,215, a *Pimpinellifolium* type from Educador. These tomatoes are considered acceptable by the growers. The resistant Marglobe cross is particularly promising.

Four similar tomatoes which derived their resistance from Plant Introduction No. 129,882 from Peru are now completely susceptible to the disease. Other named varieties developed for resistance have also acquired complete susceptibility; namely, Globelle, Veteomold, Vetomold-121, and Bay State.

Varieties introduced to the trade as resistant, apparently have but a limited period of utility before the advantage of resistance is completely lost. Apparently, this is due to the increase in the virulence of the fungus during its culture on successive generations of resistant hosts. Loss of resistance is anticipated in the types derived from Plant Introduction 112,215, and newly released to growers for trial.

The cross of Prince Borghese, an Italian esculentum paste type, with *L. peruvianum* outcrossed to Pan America (No. 44 B 292), and of the same cross backcrossed to Prince Borghese (No. 44 B 293) by W. S. Porte, United States Department of Agriculture, are now the subject of study. *L. peruvianum* is highly resistant to *Cladosporium fulvum* (Mass. Agr. Expt. Sta. Bul. 393:7, 1942). *L. peruvianum* and the wide range of phenotypes in the above crosses are also being studied for their reaction to the rootknot nematode.

**Causes and Control of Decay of Squash in Storage.** (E. F. Guba, Waltham.) Six plots of squash were grown, each of the same number of plants and identical areas of land. These plots yielded 3871, 3628, 3844, 4935, 3676, and 2742 pounds of squash, respectively.

Hubbard and Butternut squash from plots sprayed five times with Bordeaux 4-4-50 combined with 1 pound calcium arsenate were practically disease-free at harvest, in contrast to the squash from plots not sprayed with fungicide, which

<sup>2</sup>A manuscript on "The Vegetative Propagation of White Pine" has been prepared for publication.

<sup>3</sup>A paper, "Propagation of the Briarcliff Rose by Cuttings" by W. L. Doran, was published in Florists' Exchange 105:11:7, 21. 1945.



showed considerable *Mycosphaerella*, *Choanephora*, and *Alternaria* rots at harvest. The squash from the sprayed plots showed the least amount of decay in storage September 25, 1945-January 2, 1946). The sprayed plots ranked fifth in yield.

There was no difference in amount of decay between long and short stemmed squash from unsprayed field plots.

Dipping Hubbard squash in wax-water-formaldehyde emulsion<sup>1</sup> after harvest did not control decay and did not prevent shrinkage from transpiration. The same treatment of Butternut squash reduced shrinkage considerably but had no effect on the control of decay.

Detail drawings of the fungi of squash decay and photographs of the various kinds of decay have been prepared.

**Interrelation of Wettable Sulfur, Lead Arsenate, and Lime in Apple Spraying.** (E. F. Guba, Waltham.) Studies were handicapped by the lack of fruit due to freezing and unseasonal temperatures during and subsequent to the blossoming period.

Several fungicides were compared for their eradicant effect on foliage scab. Fermate 1½ pounds, Puratized N 5 E 6 1/3 liquid ounces, and lime sulfur 2 gallons in 100 gallons of water gave the best results, judged by germination studies of the scab spores sampled from the scab lesions at intervals following the treatments. Of these, Puratized gave a superior eradicant effect. The foliage was freed of viable scab spores and the scab mold was removed without any leaf injury. There was no spore germination associated with the Fermate treatment although the spores appeared normal; yet the character of the scab mold on the leaves seemed not to be changed and the amount of scab appeared to increase. The eradicant action of lime sulfur appeared good, yet there was a considerable come-back in spore germination and some burning of the foliage. A second and third treatment gave more complete disinfection of the foliage. The addition of lead arsenate contributed nothing to the eradicant action of lime sulfur.

Analytical studies of sprayed foliage showed greater initial deposits of flotation paste sulfur than of dry wettable sulfur. Weathering action caused more loss of dry wettable than of paste sulfur. Paste sulfur gave the better control of scab.

On the basis of a small tabulation of apples, the period of susceptibility to fruit russet on Baldwin and Delicious apples is believed to occur in the pink, calyx, and first cover stages in tree development. Since none of this injury is caused by a combined spray of Fermate and lead arsenate, it is recommended not to use combined sulfur and lead arsenate until the period designated "second cover."

**Resistance to *Fusarium dianthi* Prill. et Del., the Cause of a Serious Carnation Wilt Disease.** (E. F. Guba, Waltham.) From a list of carnation varieties determined to be significantly resistant to *Fusarium dianthi*, the following were retained for breeding purposes and further study.

Dorothy Napier  
Eleanor  
Elizabeth Rowe  
Georgina  
Hazel Draper  
Helen Hussey  
John Briry

King Cardinal  
Maine Sunshine  
Miller's Yellow  
My Love  
Puritan  
Tom Knipe  
Woburn

<sup>1</sup>This wax emulsion disinfectant consisted of 2 quarts formaldehyde, 20 gallons water, and 3 gallons Ceremul wax (Socony Vacuum).

Breeding (selfing and crossing) was handicapped by the failure of some of these varieties to produce pollen and by the production of pollen of others during a limited season. Seed from selfing and crossing has been obtained. More success is anticipated in another season.

Combinations of Fermate and Arasan with hormone powders in the ratio of 10 percent fungicide and 90 percent hormone powder, as a treatment of the basal end of cuttings before they are inserted in the sand, combined disease control with better rooting. Similarly, either Fermate or Arasan combined with talc in a 10-90 ratio gave good control of branch rot and was not harmful to rooting. Comparable results were secured with concentrated Fermate and Arasan. Immersion of the cuttings for 15 minutes in a 1-1,000 solution of potassium permanganate was relatively unsatisfactory. The tests were based on the varieties Eleanor, Olivette, and King Cardinal.

**Control of Seed Decay and Damping-off of Vegetable Seedlings with Seed-borne Chemicals.** (E. F. Guba, Waltham.) Since the publication of Bulletin 394, "Control of Damping-off of Vegetables by Formaldehyde and Other Chemicals," in June 1942, further seed treatment trials have been made each year. As a result of these studies, Spergon (tetrachloro-parabenzquinone) is given wider prominence, and Arasan (tetramethyl-thiuram-disulfide) is added and recommended for most vegetable seeds except crucifers. The chemical 2, 3-dichloro-1, 4-naphthoquinone (Phygon) is another valuable addition. Revisions in seed treatment recommendations have been made, based on these studies.

**Tobacco Frenching Induced by High Soil Temperature.** (L. H. Jones.) After Havana Seed tobacco plants had become established in vigorous growth at a soil temperature of 70° F., the soil temperature was raised to 95° in one half the series, while the other half was left at 70° as a check. Frenching eventually developed in all the plants at the high temperature and the check plants remained normal.

The fact that the plant containers used in previous experiments were of galvanized iron suggested the possibility of toxicity from zinc compounds made soluble by a high moist temperature in the presence of soil constituents. To eliminate this possibility, one-gallon glazed crocks were set into the two-gallon galvanized iron containers. Lime in the form of calcium hydroxide and boron in the form of borax were added to a portion of the series. The frenching symptoms appeared in all plants at 95° F. soil temperature and were absent at 70° F. regardless of other treatment. Prior to the appearance of extreme symptoms of frenching, leaves intermediate in development between normal and truly frenched exhibited an interveinal chlorosis best described as pinhead mottling. Whenever this occurred, terminal growth decreased and the tip of the plant gradually developed a rosette of typically frenched leaves. There was considerable time lag between exposure to the high soil temperature and appearance of the pinhead mottling. Plants in the glazed containers were the first to show the symptoms, 21 days being the minimum time and this in the months of February and March. Limed soil produced the largest plants and delayed the appearance of the symptoms, the time lag being 35 days. Borax delayed the appearance of symptoms still longer, 57 days, but did not reduce their severity. The cessation of terminal growth as one of the symptoms of frenching sometimes released the inhibitory influence in the development of buds in the axils of the leaves. When growth in the axils did occur on frenching plants, it was either an elongating axillary shoot with frenched leaves, eventually producing a rosette comparable to that on the original terminal shoot, or simply a rosette of frenched leaves in the axil. The elongating shoots were nearer the tip of the plant and the suppressed shoots were nearer the base.

After the experiment had been running 80 days, all the plants were topped below the terminal growing point, and half the plants which had been at 95° F. soil temperature were exchanged with plants which had been at 70°. The shift was made in April when the daylight period is longer than in February when the experiments were started. The time lag before frencing symptoms appeared in the plants shifted to the high temperature was shortened, possibly because of better growing conditions. The minimum time before the appearance of the pinhead mottling which preceded the development of frenched leaves was reduced from 21 to 14 days. The same pattern of frencing symptoms was in evidence. Axil shoots which developed on plants shifted to 95° soil temperature had a carry-over of the normal characters of the 70° soil temperature, but eventually leaves developed with the frencing characters. Plants which had been shifted from 95° to 70° soil temperature also had a carry-over which expressed itself in some cases on the axillary shoots that developed just below the decapitated terminal. These shoots showed intense frencing on the lower leaf, but each succeeding leaf was less frenched until an apparently normal leaf was finally produced. There were instances where young leaves, decidedly frenched, began to grow again when shifted to the lower temperature and became wider with less waved margins, but they never developed into leaves of normal shape. On the other hand, no leaves of normal shape developed frencing symptoms when shifted from the low to the high soil temperature.

These results suggest that soil temperature may play a regulatory role in the frencing of tobacco by affecting absorption or translocation of nutrient elements and may even affect metabolic activity to the extent of creating growth-controlling substances either by synthesis or as by-products of a breakdown of chemical compounds within the plant.

**Toxic Effect of Wood Preservatives on Plants.** (L. H. Jones.) In previous work with lumber impregnated with asphalt, injury to seedling plants was traced to a small quantity of creosote which had not been removed from the resins. It has now been demonstrated that when the creosote is entirely removed there is no injury to plants from such treated wood.

It is generally understood that the greatest damage done to green leaves by creosote fumes is by the toxic action of the gas entering the leaf through the stomata. It now appears that damage may be caused also by the dissolution of the leaf, which exposes the tender cells to the dehydrating effect of dry air. Further investigation will be necessary to confirm this type of injury.

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## DEPARTMENT OF CHEMISTRY

Walter S. Ritchie in Charge

**Factors Affecting the Vitamin Content of Milk and Milk Products.** (Arthur D. Holmes.) The investigations that have been conducted under this project during the past year, involve consideration of several factors, but the published papers dealt with two topics: the food value of ice cream as a source of common vitamins, and the vitamin content of mare's milk.

*Ice Cream As a Source of Riboflavin, Carotene, and Ascorbic Acid.* (Arthur D. Holmes, John W. Kuzmeski, Carleton P. Jones, and Frank T. Canavan.) Coffee, maple, and vanilla ice creams were manufactured on the commercial scale in the Dairy Laboratory from 24.4 pounds of cream (40 percent), 56.3 pounds of whole milk, 15.0 pounds of cane sugar, 4.0 pounds of skimmed milk powder, and 0.3 pound of gelatin. The overrun was 85 percent; i.e., 9.25 pounds per gallon of the ice cream mixture weighed 5 pounds per gallon when frozen. Ten samples



of each flavor of ice cream were assayed. The carotene content was 0.10 mg. per 100 gm.; the riboflavin, 0.26 mg. per 100 gm. No reduced ascorbic acid could be detected in any samples, probably owing to destruction by the large amount of air incorporated in commercial ice cream to increase its bulk. Comparison of these ice creams with numerous widely used foods, showed them to be excellent sources of carotene and riboflavin. Since the average yearly consumption of ice cream is estimated at three gallons per person, it contributes significant amounts of carotene and riboflavin to the human dietary.

*The Vitamin Content of Mare's Milk.* (Arthur D. Holmes, Beula V. McKey, Anne W. Wertz, Harry G. Lindquist, and Leonard R. Parkinson.) This investigation was undertaken to compare the composition of cow's milk and mare's milk—two species of animals that consume the same type of ration, but possess different types of digestive tracts. Studies have shown that the vitamin content of cow's milk is likely to be due in part to vitamins produced by bacterial synthesis in the cow's rumen, but the mare has no rumen. This, the initial paper of a proposed series, reports the results of assays of mare's milk for ascorbic and nicotinic acids, riboflavin, thiamine, bacteria, fat, size of fat globules, and total solids. Three normal, adult Percheron brood mares, in the latter stages of lactation, were used as a source of the milk. Eleven samples of fore-milk were obtained from each mare in the early morning. The average values obtained were: ascorbic acid, 12.9 mg.; nicotinic acid, 0.72 mg.; pantothenic acid (3 samples,) 2.77 mg.; riboflavin, 0.11 mg.; thiamine, 0.39 mg. per liter; bacteria, 3.70 per cc.; fat, 1.2 percent; fat globule size, 3.4 microns; and total solids, 10.20 percent. The values for ascorbic acid, nicotinic acid, riboflavin, fat, and total solids were lower than the corresponding values for milk from cows that consumed the same pasturage; but the thiamine values were higher. The greatest difference in vitamin content between mare's and cow's milk was in riboflavin. As yet, it is impossible to explain why the former has much less than one tenth as much riboflavin as the latter.

*A Study of the Changes in Vitamin Content Coincident with Different Stages and Rates of Maturity of Vegetables Used for Home Consumption.* (Arthur D. Holmes and Carleton P. Jones.) During the past year published results from the studies in this field have been concerned with kale and summer squashes grown under local climatic and cultural conditions, and supply information of particular value regarding the value of these vegetables for the human diet.

*Influence of Supplementary Calcium and Magnesium Fertilizers Upon Nutritive Value of Kale.* (Arthur D. Holmes, Leo V. Crowley, and John W. Kuzmeski.) The kale was grown on a Merrimac fine sandy loam in four experimental plots, all of which received a commercial 4-9-7 fertilizer at the rate of one ton per acre. In addition, the experimental plots received varying amounts of magnesium sulfate, ground limestone, or both, with one plot serving as a control. Twenty samples of kale were assayed for water, calcium, iron, magnesium, phosphorus, and carotene. The addition of 150 pounds of magnesium sulfate per acre definitely increased the magnesium content of the kale and may have slightly increased the calcium and phosphorus content. Limestone, applied at the rate of 1,000 pounds per acre, definitely increased the calcium and phosphorus content of the kale and may have depressed its iron content. Neither magnesium sulfate nor limestone nor both produced any pronounced effect on the water or the carotene content of the kale. As compared with other leafy vegetables kale is rich in carotene, the precursor of vitamin A. Judged by the results of this study, the use of magnesium sulfate and limestone as supplementary fertilizers enhances the food value of kale.

*Ascorbic Acid, Carotene, Chlorophyll, Riboflavin, and Water Content of Summer Squashes.* (Arthur D. Holmes, Albert F. Spelman, and Carleton P. Jones.) Seven varieties of this vegetable were studied. Five were *Cucurbita pepo* L. and two were *Cucurbita moschata* L. The ascorbic acid content of the raw squashes varied from 4.2 mg. for Cocozella to 16.7 mg. per 100 gm. for Early White Bush Scallop. Four varieties—Early Summer Crookneck, Early Summer Prolific Straightneck, Golden Cushaw, and Early White Bush Scallop—contained over half as much ascorbic acid as milk, decidedly over half as much as summer tomatoes, and from 50 to 100 percent more than late-winter tomatoes. The carotene content varied from 0.06 mg. for Early White Bush Scallop to 6.21 mg. per 100 gm. for Golden Cushaw. Two varieties, Butternut and Golden Cushaw, were extremely rich in carotene. The chlorophyll content varied from 0.42 mg. for Early Summer Prolific Straightneck to 12.25 mg. per 100 gm. for Zucchini Grey. The two squashes with green-colored skins, Cocozella and Zucchini, contained large amounts of chlorophyll. The raw squashes were rich sources of riboflavin. The Early White Bush Scallop contained about 33 percent, Butternut about 49 percent, Early Summer Crookneck about 79 percent, Cocozella more than 115 percent, and Golden Cushaw about 166 percent as much riboflavin as milk produced in this locality.

*Vitamin Content of Field-Frozen Kale.* (Arthur D. Holmes, Beula V. McKey, Katherine O. Esselen, Leo V. Crowley, and Carleton P. Jones.) It is generally agreed that the leafy green vegetables are extremely valuable components of the human diet. Unfortunately, nearly all the green vegetables are seriously damaged, if not destroyed, by freezing temperatures. Following the first killing frost, there is a considerable period during which plants that escape the frost thrive, and kale is one of these. Because of the scarcity of fresh green leafy vegetables in gardens in this area during the late fall, it seemed desirable to determine the vitamin content of field-frozen kale. Dwarf Blue-Green Scotch kale that had been subjected to freezing seven times during the previous month, was collected for assay. Eighteen samples were examined. Very mature and immature leaves were analyzed, with the following results:

	Mg. per 100 gm.	
	Very Mature Leaves	Immature Leaves
Ascorbic acid.....	158.6	212.2
Carotene.....	6.3	5.6
Nicotinic acid.....	1.94	2.21
Pantothenic acid.....	0.73	0.91

These figures supply evidence that field-frozen kale can contribute essential nutrients for the human diet, especially when the supply of fresh green leafy vegetables grown in this area is limited.

**Physico-Chemical Properties of Starch.** (Monroe E. Freeman.) The abnormal specific heats found previously for starch suspensions may be explained by the presence of a loosely bound shell of absorbed water on the starch grains. The quantitative data follow mathematical equations relating the composition of the sample, the heat of desorption, the amount of loosely bound water, and the maximum hydration capacity. The identical behavior of gum arabic, lemon pectin, egg albumin, and gelatin verifies this explanation. Cellulose, agar agar, and sodium bentonite systems apparently do not have this loosely bound fraction. This seems to be a general characteristic of hydrophillic colloids that has not been previously demonstrated.

The quantitative evaluation of this factor affords, for the first time, an accurate measurement of the specific heat of starch suspensions and permits the measurement of the heat of gelatinization. Preliminary experiments have indicated that this may be much lower than previously reported in the literature and may even be non-existent. Further experiments now in progress are expected to throw some light on the mechanism of starch gelatinization.

**The Chemical Investigations of Hemicelluloses.** (Emmett Bennett.) During the past year some of the data reported previously have been checked and certain difficulties encountered have been eliminated. The acetylation procedure generally used in this investigation would not produce the diacetate of xylan in the hemicellulose from rye straw. It was necessary to hydrate this material and to dehydrate it without exposure to air just prior to acetylation. In this way, the theoretical acetyl content could be obtained almost completely.

Results obtained so far in this investigation would seem to indicate that anhydroxylose and a hexuronic acid anhydride account for approximately 85 and 90 percent of the hemicelluloses of maize cobs and rye straw respectively. The proportions of these two constituents would correspond to a chain of anhydroxylose units approximately 30-32 units in length and terminating in a hexuronic acid group. The sugars seem to have the pyranose structure and to be connected to each other through a beta-linkage. A hexose was present to a slight extent in both hemicelluloses, while l-arabinose was detected in maize cob hemicellulose only.<sup>1</sup>

**Studies on the Quantitative Estimation of Hemicelluloses.** (Emmett Bennett.) The success of the method being tested for the quantitative determination of hemicelluloses depends upon the production of a holocellulose which contains all the hemicellulose. The percentage recovery of furfural and the color of the holocellulose were used as an index for the preparation of a holocellulose fraction which would be suitable for the quantitative extraction of hemicelluloses. A procedure suitable for the determination of this fraction in non-woody plants has been standardized. Furfural determinations on holocellulose from five different plants indicate that from 95 to 99 percent of the furfural in the original tissue can be recovered.

Nitrogenous residues seem to be the chief contaminants of holocellulose prepared from cereal grasses. In some cases 50 percent of the total nitrogen may be retained.

Preliminary extractions of hemicelluloses from holocellulose with 1.25 percent sodium hydroxide and the aid of a Waring blender for periods of different length, yield the same results. This is believed to be indicative of a complete extraction of the more loosely bound hemicelluloses, since the residual material still bears compounds which will yield furfural.

Extracts were oxidized under definite conditions by means of a solution of hot chromic acid. The amount of material oxidized was determined colorimetrically by means of a spectrophotometer. Calibration lines were constructed from data obtained by oxidizing pure solutions of glucose and xylose under definite conditions. From such lines and the percentage transmission of an unknown solution, the percentage concentration can be determined as xylose or glucose.

**The Investigation of Agricultural Waste Products. — 1. The Chemical Investigation of Lignin.** (Emmett Bennett.) The results of the study of the effects of large quantities of pure lignin upon the aerobic decomposition of plant materials appear in the forthcoming volume of the Proceedings of the American Society for Horticultural Science.

<sup>1</sup>The results have been accepted for publication by the Journal of Agricultural Research.



The present line of investigation deals with the oxidation of lignin by nitric acid and by reagents in which the cation changes valence such as ceric sulfate. No comments are warranted at this time.

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## CONTROL SERVICES

Philip H. Smith in Charge

The fertilizer, feed, seed, and milk testing laws are administered as one service and the operations of each of these, with the exception of the milk testing law, are reported in annual bulletins issued for that purpose.

Under the milk testing law 5,623 pieces of Babcock glassware were tested for accuracy and 107 certificates of proficiency in testing were issued. In addition, all milk depots and milk laboratories in the State, of which there are 192, were visited at least once, as required by statute, in order to check apparatus and the general conduct of the work. It can be assumed that the greater part of the milk sold in Massachusetts is now paid for on the basis of weight and test rather than by the quart.

Under the fertilizer act the number of brands registered was about the same as for 1945; 258 in 1945 and 260 in 1946. This in spite of Federal regulations and the effort of agronomists to reduce the number of grades manufactured. The number of samples collected and analyzed has been less than for normal years but it is believed that the samples collected fully represent the grades offered in Massachusetts. Deficiencies (variations from guarantee) have not been so extensive as in previous years.

While the tonnage of feed sold in Massachusetts has been reduced because of shortages, many brands have been found that have not been previously offered for sale within the State. This has been due in large measure to the inability of many feed manufacturers to fill the requirements of their customers, who have therefore been obliged to look to smaller mills in the Middle West.

The work of the seed laboratory has continued to grow, largely on account of the realization on the part of seed dealers of the prime importance of good seed if good crops are to be expected. Through the Federal Seed Act, where seeds have entered into interstate commerce, the laboratory has been able, through cooperation of the Federal officials, to cause the prosecution of flagrant violations. This as a Federal and not as a State matter.

Considerable time has been devoted to assays and analyses not directly connected with the Control Acts but for which there appears to be a need. With increasing knowledge of the role of trace elements in plant and animal nutrition, the fertilizer and feeding stuffs laws should be made more comprehensive so as to include such elements where their presence is indicated as a part of the guarantee. Such legislation should also include vitamins where their presence is claimed.

As in the past, the Control laboratories have examined fertilizers, feeding stuffs, and other material for citizens of the State without charge wherever the work could be considered of general public value. More than the usual number of samples of feed were received which the feeders claimed to have caused the death of poultry. With few exceptions the contention could not be proved by any analysis to which the feed was subjected.

In addition to regular routine duties Control Service has been called upon to the extent of time available to assist other departments of the College and Station in conducting work in connection with research problems not originating in the department itself.

## THE CRANBERRY STATION

East Wareham, Massachusetts

H. J. Franklin in Charge

**Injurious and Beneficial Insects Affecting the Cranberry.** (H. J. Franklin.)

**DDT.** This insecticide was advocated as a control for gypsy moth caterpillars in the annual Cranberry Insect and Disease Control Chart in the spring of 1946, and it was used widely and freely both on bogs and on the surrounding uplands, especially in Plymouth County, with entirely satisfactory results. In spraying, complete kills were obtained with 2 pounds of the 50 percent wettable powder in 100 gallons of water, 400 gallons to an acre; and with 3 pounds in 100 gallons, 250 gallons per acre. In dusting, 50 pounds of the 5 percent dust to the acre was used. No injury to cranberry vines from the DDT appeared.

DDT was used considerably as a spray and as a dust treatment for the first brood of the black-headed fireworm in May and early June, 1946, in the amounts found effective against gypsy moth caterpillars, and the control appeared to be satisfactory in all cases. Its further use against first-brood fireworms seems advisable. It probably should not be used on second-brood fireworms or on blunt-nosed leafhoppers till more is known about its effects on bees.

**Fireworm Flooding.** Flooding for as short a period as 10 hours to kill the less-than-one-third-grown black-headed fireworms of the first brood was tried very successfully in 1945 and was advocated in the 1946 Cranberry Insect and Disease Control Chart. Various cranberry growers tried this treatment in the spring of 1946, some of them with excellent results. It was found that, to be entirely successful, it has to be repeated once or twice at intervals of a week to 10 days. The success of this treatment seems to be based on the following facts:

(a) It is especially important to kill the leaders of the first brood of worms, for their moths lay most of the eggs which produce the second-brood worms of this only partially two-brooded insect.

(b) A short flooding kills the smaller worms more easily and completely than the larger ones.

(c) Short floodings are less likely to harm cranberry vines than the longer ones heretofore employed.

**Dusting by Airplane.** Extensive tests of dusting by airplane were conducted by the A. D. Makepeace Company in the spring of 1946. Observations of the results indicated that this method of treatment is practicable on cranberry bogs when properly applied. It probably will come to be used widely in treating the gypsy moth and the black-headed fireworm.

*Prevalence of Cranberry Insects in the season of 1945:* -

1. Gypsy moth infestation moderate, but heavy in some sections.
2. Leafhoppers (*Ophiola*) not very plentiful.
3. Fruit worm infestation lighter than for many years, in very striking contrast to the severe infestation of 1944.
4. Black-headed fireworm less troublesome than usual.
5. Practically no fire beetles (*Cryptoccephalus*) found.
6. Very few spotted fireworms (*Cacoecia*) found.
7. Ladybugs normally abundant.
8. Spanworms in general not troublesome.
9. False armyworm (*Xylena*) infestation normal.
10. Black cutworm (*Euxoa*) infestation medium, mostly on bogs flowed for control of root grub (*Amphicoma*).

11. The armyworm (*Cirphis*) broke out on a good many bogs from which the winter water was let off late. They appeared in some cases where the water was let off as early as May 20. This was very unusual and may have been due to the very warm weather in March and April.

12. Cranberry girdler (*Crambus*): General infestations by this insect on the Cape Cod cranberry bogs were more severe than for many years, this evidently being due largely to lack of sanding because of labor shortages and to lack of dusting because of the shortage of Pyrethrum.

13. Spittle insect, cranberry weevil, and tipworm infestations about normal.

14. Bumblebees and honeybees less abundant than usual. Scarce on many bogs.

**Weather Studies.** (H. J. Franklin.) A project entitled "The Relationship of Weather to Cranberry Production through its Various Effects on Photosynthesis and Growth," established in December 1935, was brought to a close in May 1946, and the results were presented for publication as a bulletin of the Station.

Frost forecasts were continued as a special service, 212 cranberry growers subscribing to the telephone service. The forecasts by radio were cooperative between the United States Weather Bureau office at Logan Airport and the Cranberry Station at East Wareham and were distributed by stations WEEI at Boston and WOCB at West Yarmouth.

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## DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

**New Sterilizing Agents for Dairy Use.** (W. S. Mueller, E. Bennett, and J. E. Fuller.) The germicidal properties of the following surface-active agents have been investigated further: 9 quaternary ammonium compounds, 3 phosphonium compounds, 3 substituted phenols, 10 alkyl aryl sulfonates, 1 aryl alkyl polyether sulfonate, 1 aliphatic sulfonate, 1 aryl alkyl polyether alcohol, 2 polyoxyalkylene of fatty acids, 1 aliphatic sulfate, 1 aryl alkyl polyether sulfate, 4 monoesters of polyhydroxy compounds, and 6 unknowns. Other properties which were investigated are stability, corrosiveness to metals, solubility, odor, taste, and color. Germicidal tests made within one year after the surface-active agents were obtained showed that 9 were effective sterilizing agents, 9 were moderately effective, and 24 were ineffective. The effective group included only quaternary ammonium and phosphonium compounds; while the moderately effective group included substituted phenols, alkyl aryl sulfonates, and aliphatic sulfonates. One or more of the materials of each class were represented in the ineffective group, with the exception of phosphonium compounds, substituted phenols, and aliphatic sulfonates. After  $2\frac{1}{2}$  years of storage only the quaternary ammonium and phosphonium compounds retained their effective germicidal properties, while all of the materials which were found to be moderately effective at first had lost most of their germicidal properties during storage. No correlation was noted between pH values, germicidal property, and stability of the products. The quaternary ammonium compounds were readily soluble, were not objectionably corrosive to metals, and were practically odorless, tasteless, and colorless, all of which are desirable properties of a dairy sterilizing agent. While the phosphonium compounds also were non-corrosive to metals and had no serious objectionable odor and taste, they did not go into solution readily and produced cloudy solutions. Results to date indicate that only the quaternary ammonium



compounds show more than ordinary promise as a superior sterilizing agent for dairy use. A paper on this study has been submitted for publication.

**Effect of Certain Antioxidants on the Flavor and Keeping Properties of Milk and Some of Its Products.** (W. S. Mueller.) Further studies have been made on the antioxidative properties of cacao-shell and cocoa powder and certain extracts of these products, by noting their effect in butter oil, with and without added copper. Two accelerated tests, the Modified Schaal Test and the Swift Fat Stability Test, were used and the following determinations were made: Peroxide value, color (indirectly vitamin A), taste, and odor. The cacao antioxidant was more effective for butter oil in the presence of copper than in the absence of the metal, and was a potent inhibitor of the pro-oxidant effect of copper. The natural inhibitors of cacao-shell and cocoa powder were successfully extracted with suitable solvents. Drying the extracts to a powder did not significantly decrease their protective properties. The cacao inhibitor was found to be more potent than the natural inhibitors of wheat germ and of oat flour. A cacao-tannin was isolated from cacao shell and was found to be less potent as an inhibitor than pure tannic acid.

**Study of Packaged Ice Cream.** (J. H. Frandsen.) During the year further studies have been made in comparing the palatability of packaged and bulk ice cream under factory, drugstore, and ice cream retail store dipping conditions. Results of studies here and conferences with men in plants indicate that, under ideal conditions and with trained personnel, losses in dipping bulk ice cream may be reduced to from 20 to 30 percent. However, under ordinary conditions and with unskilled scoopers, there is a loss of from 30 to 40 percent in volume from packaging bulk ice cream as compared with the same ice cream machine-packaged directly from the freezer.

Our research work would indicate that if packaged ice cream is made from mix of the same composition as bulk ice cream, and if the overrun of the packaged ice cream is reduced 15 percent from that of bulk ice cream, the resultant ice cream should be fully as palatable and nutritious as bulk ice cream. This should overcome the prejudice now existing against packaged ice cream. The trend is towards packaged products, and packaged ice cream is in line with this trend. Machine-packaged ice cream can be kept at a lower temperature than bulk ice cream and therefore should reach the home of the cash and carry consumer in a more satisfactory condition than the warmer hand-packaged bulk ice cream.

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## DEPARTMENT OF ECONOMICS

Philip L. Gamble in Charge

**Effects of the War and Readjustments in Massachusetts Agriculture.** (David Rozman.) The major phase of the work on this project has been completed and the results presented in Bulletin 430 published under the title, "Postwar Readjustments in Massachusetts Agriculture." Of special significance among the various readjustments emphasized by the results of the study is the reconstruction of land resources in farming areas. Other important facts and recommendations brought out by the study are:

1. More than half of the commercial farming units in Massachusetts fail to meet desirable requirements of income for farm families.
2. The greatest need is for the reconstruction of substandard farming units into efficient, economic family farms capable of providing an adequate level of living under modern conditions.

3. The classification of soil and field investigations carried out in a number of towns indicate that improvement of undeveloped areas, where the cost is justified by resulting benefits, may serve to enlarge and improve land resources on existing farms, to make possible the replacement of poor land now in use, and to provide for new farming units.

4. Improvement in the condition and productivity of pasture and hay lands, the most important assets in Massachusetts agriculture, will reduce costs and improve the position of many Massachusetts farms.

5. Management of farm woodlands, which represent about 37 percent of the total area of Massachusetts farms, should be integrated with other farming operations to secure higher returns to producers.

6. The position of Massachusetts agriculture in the postwar period will be determined by the successful reduction of costs through the adoption of the most efficient methods, whether they are in the use of land resources, the employment of labor, the use of machinery, or the marketing efforts.

Additional material, prepared in connection with agricultural readjustments was presented in a manuscript dealing with the 1946 production program for Massachusetts agriculture.

## DEPARTMENT OF ENGINEERING

C. I. Gunness in Charge

**Cranberry Storage Investigation.** (C. I. Gunness, H. J. Franklin, and H. F. Bergman.) Storage investigations on cranberries were continued during the 1945 season. Berries were put in storage on September 7 and removed and screened on November 1. Losses under different conditions of storage were as follows:

	Percentage Loss	
	At Screenhouse Temperature	At 45 degrees
In normal atmosphere.....	8.4	5.6
In controlled atmosphere:		
11 percent carbon dioxide.....	12.3	
2.5 percent carbon dioxide.....	.	7.4

Berries stored in a carbon dioxide atmosphere, even at the low concentration of 2.5 percent, colored much less than those stored in normal atmosphere. Berries stored at 45 to 50 degrees color much more than those held at lower or higher temperatures, all being stored in normal atmospheres.

Storage of berries in refrigerated rooms at temperatures from 35 to 45 degrees will reduce storage losses considerably below that which occurs in the common screenhouse. Storage in controlled atmosphere holds but little promise of success.

**Poultry House Investigation.** (C. I. Gunness and W. C. Sanctuary.) In the study of poultry housing, emphasis was placed on method of ventilation and arrangement of equipment to permit the housing of the maximum number of birds in a given pen. The test pen housed 150 birds, allowing 2.66 square feet per bird. This pen would normally house only 100 birds, and this number was housed in the check pen which is equal in size to the test pen. Better use of floor space was obtained in the test pen by raising feed hoppers and watering troughs off the floor. The down-draft baffle ventilator was used in this pen, opened to the extent that ventilation was increased proportionately with the

increase in the number of birds as compared with the check pen. The litter was not changed during the season. At the end of the season the litter in the check pen housing 100 birds had a moisture content of 28 percent. In the test pen housing 150 birds, the moisture content of the litter was 36 percent. Egg production was equal in the two pens, but mortality was slightly higher in the crowded pen.

Electric ventilation was compared to natural ventilation through windows utilizing the down-draft baffle device. The electric fan was installed in a pen at the east end of an uninsulated house, while the check pen was the center pen in a three-pen insulated house. The electric fan was so installed as to circulate 300 cubic feet per minute, discharging through a long duct placed near the floor at the front of the house. The fan sucked in 90 cubic feet of fresh air per minute from the outside. The windows remained closed during the season. Foul air was discharged through an opening in the floor at the east end of the pen. The fan ran continuously and drew 40 watts.

The litter was not kept as dry as in former years, presumably because the pen was more crowded. The pen housed 100 birds, the same as the check pen. At the end of the season the litter contained 51 percent of moisture. Relative humidity in the pen was higher than in the check pen, but very little frost accumulated on the ceiling and temperature was kept higher than would have been possible with window ventilation. Egg production was slightly higher than in the check pen and mortality no higher.

**Hay Drying.** (C. I. Gunness and J. G. Archibald.) Mow drying of loose hay was continued in one of the college barns. This installation was used to take care of lots of hay which were too wet to put in the barn and which would very likely have been injured by rain if left out another day. The installation seemed very much worth while from this standpoint.

Three installations in the State have been available for study and observation. One, made in 1945 for drying baled hay, has a capacity of 50 tons and was filled three times in 1945 for three cuttings of alfalfa. Some of the bales contained up to 43 percent of moisture and in general came out very well to the satisfaction of the owner. One lot was put in in June of this year. Because of the excellent weather for haying, the bales were not put in as wet as last year, but wet enough so the hay has come out in good condition with excellent color.

Two other installations have been made in which air has been heated by being passed over steam radiators. The advantage of heating the air has been quite apparent, but a full report on this season's operations can not be made at this time.

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## DEPARTMENT OF ENTOMOLOGY

Charles P. Alexander in Charge

The early season of 1945 was characterized by very unusual weather conditions. During March there occurred a period of extremely hot weather which stimulated both plant and insect growth. European corn borer development was hastened so that pupation of overwintered larvae began much earlier than usual, and fruit bud development by the end of the month was approximately a month ahead of normal. In April, conditions reverted to ranges more normal for March, culminating in the freeze of April 23 which caused very general and severe damage to fruit buds and destroyed the crop in many orchards. May was cold and wet, conditions which were very unfavorable for activity of European corn borer moths and held the first brood of borers to such a low point that early corn suffered very slight damage whether treated or not.



The outstanding feature of June was excessive rainfall. Rain occurred on 17 days and the total rainfall for the month was 7.67 inches, a record exceeded only three times since the weather station in Amherst was established. One of the most severe hailstorms in recent years occurred on June 15, accompanied by 1.85 inches of rain. Hail knocked down some fruit and severely scarred most of that which remained on the trees. The hail also caused severe breakage of potato plants and the heavy rain washed some areas badly. The plots were flooded for more than 24 hours and neither spraying nor cultivation could be attempted for a week.

July was marked by heavy and frequent rains. The potato plots were again flooded and no spray equipment could be operated through them from July 9 to 23. Following this setback, plants in all but the higher areas began to turn yellow and died prematurely. During this period also, blight began to appear. Hot humid weather further aggravated the situation. Plants in most of the plots never recovered, and yield records could be taken from only small areas of higher elevation in the field.

**Investigation of Materials Which Promise Value in Insect Control.** (A. I. Bourne and W. D. Whitcomb.) Work in connection with the cooperative project with the Dow Chemical Company was continued in 1945, both at Amherst and Waltham.

Through the growing season, apple aphids were very scarce and there were practically no leafhoppers. European red mites were not only scarce but practically nonexistent throughout the college orchards and commercial orchards near by. It was not until about early September that there was any evidence of this pest. Then a sudden outbreak occurred in which a moderate to heavy infestation developed and some bronzing occurred. The attack was of comparatively short duration.

The experimental materials, Dinitro compounds D 289, D 389, C 506, and D 524, applied to apples while they were dormant, practically eliminated all aphid infestation, while on unsprayed checks the infestation averaged 720 aphids per 100 buds. None of the materials caused any direct injury to opening buds or retardation in seasonal development.

D-542 Dinitro-ortho-cresol, at both 4 and 5 percent strengths, caused an almost perfect kill of oyster shell scale on lilac.

The outstanding feature of the season's program was the successful control of the blueberry bud mite (*Erophytes vaccinii*) in commercial plantings by the use of Dn-111 in early June. Previous to these tests no spray application had been successful as a control measure. Dn-111, 20 ounces, plus Ultrawet spreader, 8 ounces, per 100 gallons reduced the number of mites per bud on the varieties Pemberton and Wareham from 54 and 59 before spraying to an average of 2.5 mites per bud for the two varieties, within 24 hours. Some injury resulted.

A second series of tests in which Dn was applied at strengths of 16 - 20 ounces per 100 gallons and at 150 pounds pressure instead of 400 pounds as in the first series, gave successful control of the mites in 24 to 48 hours and caused no serious burning. The concentration of the spray seemed to make little difference, but the reduction in pressure appeared to be an important factor in preventing injury.

In a late-season outbreak of European red mite on apples and beach plums, both Dn-111 and D-4 gave 98 to 99 percent control within 24 hours.

**Studies of Different Forms of DDT.** (A. I. Bourne and W. D. Whitcomb.) Materials tested were supplied by Geigy Company, Inc., and included Gesarol AK-40, Gesarol A-20 (water dispersible powders), and A-5 dust.

*Orchard Tests Against Apple Pests.*<sup>1</sup> Because of the adverse weather conditions mentioned above, several readjustments had to be made in the plans for the experiment. The set of fruit was light and scattering and much of it was severely damaged by hail. In the face of such handicaps the results of the season's work cannot be given as much weight as could be desired, but some significant differences were noted. Yield records were taken on McIntosh only.

On unsprayed checks, such fruit as survived the frost and hail damage ripened and dropped prematurely. Practically all of it was infested by curculio, codling moth, and apple maggot and blemished by scab.

DDT gave excellent control of codling moth. At a dosage of 1 pound Gesarol AK-40 (0.4 pound DDT) per 100 gallons, only 1.5 percent damage was recorded; and at a dosage of 2 pounds, no injury was found. The standard spray schedule in this block held codling moth damage to 3 percent.

DDT was not as effective against plum curculio as was the standard schedule with lead arsenate, although a combination of lead arsenate and DDT gave somewhat better control than lead arsenate alone.

No evidence of apple maggot damage appeared in any sprayed plot.

*DDT on Potatoes.* Reports that DDT has proved a good insecticide for potatoes would appear to be borne out in the 1945 tests. A spray containing 0.4 pound DDT (1 pound Gesarol AK-40) per 100 gallons combined with a 10-5-100 homemade Bordeaux mixture was used in the test plot. No aphid infestation developed in this plot during the season. There was a very conspicuous reduction in flea beetle damage in the DDT plot, and the highest yield of any of the plots (273 bushels per acre compared with 261 following standard 10-10-100 Bordeaux mixture with calcium arsenate). The vines in the DDT sprayed plot showed consistently more vigorous growth and remained green for a longer period than in any other plot.

The results of these tests in a season of very unfavorable weather conditions, correspond closely with those reported elsewhere. It can be expected that DDT will become an important element in the spray program for potato pests.

*DDT on Onions.* DDT spray at 0.4 pound DDT (2 pounds Gesarol A-20) per 100 gallons gave 89 percent control of onion thrips, as compared with 90 percent following application of a 4 percent derris powder (4 pounds per 100 gallons) and 91 percent following a fixed nicotine spray (3 pounds per 100 gallons). A 5 percent DDT dust gave 90 percent control compared with 81 percent following a 1 percent rotenone dust.

In a second series, heavy rain a few hours after application appeared to cut down the efficiency of most of the materials. DDT spray gave 82 percent control; derris 83 percent; and fixed nicotine, 80 percent. DDT dust gave 70+ percent control; rotenone dust, 61 percent. These results indicate that DDT was affected much less by rain soon after application than were the other materials.

Records of treated plots four days after treatment showed that DDT spray was giving 85 percent control, derris 38 percent, and fixed nicotine 71 percent. DDT dust showed 98 percent control; rotenone dust, 24 percent. Apparently DDT had a considerable residual effect.

In a third series, the Rohm & Haas wetting agent, Triton X-100, 6 fluid ounces to 100 gallons, was used with all spray materials and made a vast improvement in application and resultant effectiveness. DDT gave 99+ percent control, and derris 98.8 percent, in comparison with unsprayed checks. DDT dust gave 93 percent control.

<sup>1</sup> Further details of these tests will be found under the project "The Value of Control Measures to Supplement the Standard Spray Program for Apple Pests in Massachusetts."

*Rose Chafer.* In two series of laboratory tests against the rose chafer, DDT spray at dosage of 0.4 and 0.8 pound DDT (Gesarol AK-40) and a 5 percent DDT dust proved very effective. Within one-half hour beetles began to show poor coordination, and became more and more inactive and helpless. After 5 to 6 hours practically all beetles were quite inactive and in about two days all died. There was practically no evidence of feeding or other normal activity after treatment.

*Gypsy Moth.* In three series of tests, one-half to three-fourths grown larvae soon began to show ill effects, poor coordination of muscles gradually increasing to inactivity. Within two to three days practically all had died. Full-grown larvae succumbed somewhat more slowly and in few cases attempted to form pupae. There was very little or no evidence of feeding after treatment.

A young planting of one-year-old apples, which showed an average infestation of about three half-grown larvae per tree and considerable foliage injury before treatment, was cleared of the infestation with one application. Half the block was sprayed with 0.8 pound DDT (2 pounds Gesarol AK-40) per 100 gallons, combined with a wettable sulfur fungicide. The rest of the block was sprayed with lead arsenate, 5 pounds to 100 gallons, plus wettable sulfur and excess lime. Examination five days after treatment showed no larvae on DDT rows, but one larva following arsenical spray.

*Tarnished Plant Bug on Potatoes.* A commercial planting of potatoes was attacked by tarnished plant bugs migrating from a recently cut field of clover and swarming over the plants of several rows of potatoes. Almost every growing tip was attacked and many were killed. One spray application of DDT, 0.5 pound per 100 gallons, cleared the field of bugs in about three days, and subsequent application to potatoes and an adjoining strip of clover stubble prevented further migration. The plants recovered and yielded an excellent harvest.

*European Corn Borer.* The infestation throughout the State was very light in 1945, particularly in the Connecticut Valley region. This was due in large part to adverse weather conditions during the period when moths were present. Emergence was prolonged, moth activity was seriously reduced by cold, wet weather, and egg laying was very slight and irregular.

A spray containing 2 pounds Gesarol A-20 (0.4 pound DDT) per 100 gallons, plus Ultrawet spreader, was used in four applications on sweet corn. Gesarol A-5 dust was also used in a similar schedule. Counts of tassel breakage as an index of stalk infestation, made just before harvest, showed no breakage at all in DDT plots (either sprayed or dusted) and only 9.5 percent breakage in untreated checks.

Yield records showed 2 infested ears out of a total of 265 (0.75 percent) in the plots sprayed with DDT. No infested ears were found in the dusted plots. Un-sprayed checks yielded 239 ears, of which 4 (1.7 percent) were damaged by corn borer.

**The Value of Control Measures to Supplement the Standard Spray Program for Apple Pests in Massachusetts.** (A. I. Bourne, in cooperation with the Departments of Pomology and Plant Pathology.) The set of fruit was so light and uneven that the schedule of tests originally planned for this block had to be rearranged and all of the DDT series had to be relocated. Such records as were possible were taken from McIntosh plots at harvest. The crop of Baldwins, which was due to be light, was practically wiped out by the freeze and subsequent hailstorm.



*Supplements to the Standard Schedule.* On unsprayed trees the severe attack of all insect pests and the unusual severity of scab caused what fruit survived the early freeze and subsequent hail to drop by early August. Practically all of this was infested by scab, curculio, and codling moth.

In the plots receiving the standard schedule, there was 7.3 percent damage from curculio, 10.5 percent from codling moth, and 35 percent from scab. Only 48 percent of the fruit in this plot was free from disease or insect blemishes.

In the plot where the "emergency A" spray was interposed between the 2d and 3d cover sprays, there was 82 percent clean fruit, 3 percent showing curculio injury, 1 percent showing codling moth injury, and 13.6 percent marked by scab.

The record of apples from the plot in which the standard schedule was supplemented by the "emergency A" spray and a late application of fixed nicotine spray at mid-August showed 84.4 percent clean fruit free from all blemishes, less than 1 percent codling moth damage, and slightly less scab.

The reduction of codling moth injury following the "emergency A" spray was especially significant (from 10.5 to 1 percent), and indicated the importance of this application. The record also indicated that its timing coincided very accurately with the seasonal development of the insect.

In a separate block of McIntosh, different dosages of DDT were employed, in five applications (May 15 to July 25) following the calyx spray. The standard schedule was followed up to and including the calyx spray; and part of the block received the full standard schedule throughout the season to serve as a basis for comparison. In the standard schedule, lead arsenate was used in combination with wettable sulfur and lime. The DDT was also combined with wettable sulfur but without the addition of excess lime.

DDT (AK-40) at dosage of 1 pound and 2 pounds per 100 gallons of spray did not control curculio as well as did a combination of lead arsenate 2 pounds and DDT  $\frac{1}{2}$  pound, even with the addition of a fish oil sticker in the 1st cover spray. Codling moth was well checked in all DDT plots (0 to 1.5 percent injury for the higher dosages, and 2 injured apples out of 32 in the DDT plus lead arsenate plot). Scab was well controlled in all plots, indicating that the presence of DDT did not interfere with the efficiency of wettable sulfur. There was very slight evidence of damage by miscellaneous minor insect pests, and no trace of damage by apple maggot in the fruit of any of the sprayed plots.

*Abbreviated Schedule.* With a serious cut in the crop resulting from the killing of the blossoms by frost and subsequent cold weather, many growers were contemplating the use of an abbreviated spray schedule to give moderate protection from insect pests and particularly from apple scab of such fruit as survived, and looking forward to maintaining the trees in good condition for the following season.

One section of the orchard was given a limited post-blossom schedule or a special sulfur dust and a sulfur spray combination for scab control, a special cover spray of sulfur and lead arsenate in early June, and the first apple maggot spray on July 12.

Following the standard schedule, records showed 87 percent clean fruit, 5.8 percent injury by curculio, 2.5 percent by codling moth, 0.8 percent by scab, and 2.9 percent by miscellaneous minor pests. Following the abbreviated schedule, there was 71 percent clean apples, 2 percent damage by curculio, 5 percent by codling moth, 2 percent by scab, and 2.4 percent by minor pests. There was only a trace of apple maggot damage in the entire orchard.

Codling moth, scab, and apple maggot were well checked by a modified schedule and the foliage was maintained in good condition. Curculio damage was high following the abbreviated schedule, since no special application was made

for its control. Most of this fruit could be salvaged, however, and the trees were in good vigorous condition going into the winter.

*Heavy Deposit-Building Dust Against Late Codling Moth.* The dusts were used in three applications covering the period from July 12 to August 9, which spanned the period of heavy hatching of eggs and appearance of late season larvae of 1st brood codling moth and of early 2nd brood larvae.

The heavy deposit-building dust proved somewhat superior to spraying, and the standard dust was approximately equal in value to spraying. Against apple scab (in a season of exceptionally heavy infection) the heavy deposit dust gave protection very comparable with the spray. The standard dust was less effective. Late summer damage by miscellaneous insect pests was uniformly low in all plots, and apple maggot injury was nil.

*Insecticides for the Control of the European Corn Borer.* (A. I. Bourne.) Some corn borer moths emerged before the corn had appeared above ground, the first recorded emergence being April 30. The period of emergence was prolonged over a number of weeks—considerably longer than normal—and evidently the unfavorable weather interfered to such an extent with moth activity that the first brood of borers was negligible. This was evidenced by the scarcity of egg masses and by the record of tassel breakage, counts of which were made in the experimental fields just before the crop was picked. In the check plots the percentage of infested tips was 9.5, while in the treated plots the percentage varied from 0 to 2.4, with a weighted average of 1.4 percent. The very light infestation was further shown in the yield records. The yield in *all* plots was 1532 ears, of which only 15 were found infested. In all the treated plots, 1293 ears were harvested, of which 11 (0.8 percent) were infested. Unsprayed check plots yielded 239 ears, of which 4 (1.7 percent) were infested.

Even with such a slight infestation, the percentage of marketable corn in proportion to total yield reflected the effect of the borer attack. At the first picking the yield in sprayed plots ranged from 44 to 68 ears per plot; in the check plot only 23 ears were ready to pick. In the treated plots 96 to 100 percent of the total yield was of marketable grade; in the unsprayed check, 91 percent.

*Potato Spraying Experiments.* (A. I. Bourne.) Flea beetles were normally abundant early in June, and the second attack occurred in late July and August.

No leafhopper infestation occurred, and there was no serious threat by aphids. A small attack appeared in July, but an application of nicotine sulfate checked it before more than a very light attack developed.

The plots were given twelve applications between June 11 (flea beetles appeared about June 8-9) and September 11, when no new growth was taking place. No evidence of injury to vines following any of the sprays was noted.

The most significant differences in flea beetle damage were between the DDT plot (attack very light) and the Dithane plots (attack very severe). In both the Bordeaux and the Dithane plots the addition of calcium arsenate materially reduced the severity of attack. This was especially noticeable in the case of Dithane, which appeared to give very little protection from flea beetle when used alone. There was no significant difference between the two strengths of Bordeaux, but there was a very appreciable reduction in all cases where calcium arsenate was used. Flea beetle damage in the DDT plot was insignificant throughout the season. As the season progressed, the increased injury by flea beetles in the Dithane plots indicated that the repellent action of sprays in near-by plots might have driven the beetles to the Dithane-sprayed plants. The sharp decline in leaf perforation following the application of calcium arsenate indicates that the arsenical is essential when Dithane is used.

The damage caused by abnormal weather conditions was so severe that yield records could be taken from only 50 feet of row across the north (higher) end of the plots. The crop throughout the entire field was much lower than normal.

The yield in the plots receiving standard 10-10-100 Bordeaux and 10-5-100 Bordeaux was approximately 195 bushels per acre in both cases. Where calcium arsenate was added to Bordeaux, the yield was approximately 35 percent greater.

The lowest yield occurred where Dithane alone was applied. When calcium arsenate was added to Dithane, the yield was about 50 bushels per acre greater and only slightly less than the yield in the standard Bordeaux plot where calcium arsenate was included and greater than in the low-calcium Bordeaux plots. Dithane appeared to have held blight in check to a degree at least comparable with Bordeaux in spite of the adverse weather conditions and the inferior appearance of the plants throughout late summer.

The highest yield in the entire field was in the plot where DDT was applied (273 bushels per acre compared with 261 bushels per acre following standard Bordeaux plus calcium arsenate). This was in line with the superior vigor and excellent appearance of the plants in this plot throughout the season.

Reports that DDT is a very good insecticide for potatoes seemed to be borne out in 1945. No aphid infestation developed in the DDT plot although a slight infestation started in other plots. There was a very conspicuous reduction in flea beetle damage and the highest yield in the whole field. The plants were more vigorous throughout the season and remained green longer than in any other part of the field. The results here correspond very closely with those reported from other regions and were so generally favorable that this material may be expected to become an important element in the spray program for potato pests.

**Control of Onion Thrips.** (A. I. Bourne.) A spray of a 4 percent derris (4 pounds per 100 gallons) with Ultrawet wetting agent gave 90.5 percent control of thrips, DDT (0.4 pound per 100 gallons) 89.1 percent control, and Lethane B-72 (3 pounds per 100 gallons) 48.2 percent control, as compared with 91-92 percent control following application of Black-Leaf 40 with the same wetting agent.

A 5 percent DDT dust gave 90 percent control in one test and 93 percent following a heavy application. A 1 percent rotenone dust furnished 81 percent protection, and a Lethane dust (B-71) 78 percent control in light application and 95 percent following a very heavy dusting.

The wetting agent Triton X-100 appeared to be very well suited for use on the smooth waxy surface of onion plants and improved the effectiveness of all spray materials greatly, derris spraying giving 98.9 percent control, and DDT 99.4 percent immediate control with marked residual action. Lethane B-72 gave 96 percent control but no prolonged protection.

No injury was noted following the application of any of the above materials.

**Naphthalene and Similar Compounds as Greenhouse Fumigants.** (W. D. Whitcomb and Wm. Garland, Waltham.) A paste containing a naphthalene base fumigant was developed for painting on steam pipes to eliminate the use of vaporizing units. Experimental fumigations on carnations with this paste at 70°-75° F. for a 6-hour exposure gave satisfactory control of the common red spider at dosages of 6/10 ounce and 8/10 ounce per 1,000 cubic feet, but were unsatisfactory at a dosage of 4/10 ounce per 1,000 cubic feet. Potted cucumber and tomato plants were slightly injured by the treatment.

**Biology and Control of the Red Spider Mite on Greenhouse Crops.** (W. D. Whitcomb and Wm. Garland, Waltham.) Tests of three commercial spray materials containing 5.4 percent and 3 percent rotenone in four applications at



weekly intervals to greenhouse roses indicated that they will not give good commercial control of the red spider mite under these conditions. In experiments where a partially satisfactory kill was recorded, a severe infestation developed soon after spraying was discontinued.

An experimental benzene mixture killed the red spider mite well but caused excessive injury to rose foliage, while an emulsified monochlor naphthalene mixture was both injurious to rose foliage and ineffective against the mite.

**Control of Cabbage Maggot.** (W. D. Whitcomb, Waltham.) With a moderate field infestation by the cabbage maggot, untreated plants of the Early Jersey Wakefield and the Charleston Wakefield varieties were 94 and 88 percent free from injury, indicating considerable resistance compared to Golden Acre and Super Curled Savoy with only 47 and 12 percent of the plants free from injury. On Golden Acre one application of 4 percent calomel-talc dust in a small mound about the stem of the plant gave perfect protection and produced 90 percent salable heads. Corrosive sublimate solution (1 ounce in 10 gallons of water) in two applications gave 95 percent protection. DDT-talc dust containing 5 percent DDT, when applied twice at weekly intervals with a hand duster, gave 95 percent protection and was more effective than a 3 percent DDT-talc dust applied either with a duster or in a mound around the stem of each plant. A DDT solution containing 1 percent DDT applied in the same way that corrosive sublimate solution was used was quite effective but caused injury to the roots of the plant, apparently due to the action of the solvent rather than of the DDT.

**Control of Plum Curculio in Apples.** (W. D. Whitcomb, Waltham.) In laboratory poison studies, spray suspensions containing 2 pounds or more actual DDT in 100 gallons gave reasonable control of the plum curculio. Two pounds of actual DDT in 100 gallons were approximately as effective as 4 pounds of lead arsenate. The time required to kill the beetles and the number of punctures made in sprayed apples decreased consistently as the amount of DDT in the spray was increased, and a spray containing 4 pounds of actual DDT in 100 gallons of water (0.5 percent DDT) gave almost perfect protection. Combinations of lead arsenate and DDT were generally more effective than equal amounts of either material alone. A combination of 4 pounds of lead arsenate and 2 pounds of actual DDT in 100 gallons was very effective and highly promising for practical use.

Orchard experiments were greatly limited by a general crop failure following destructive spring frosts, and the infestation of the plum curculio was very heavy.

Applications of the regular schedule on Golden Delicious apples using wettable sulfur 4 pounds, a sulfated alcohol spreader 2 ounces, with the following materials in each 100 gallons of water gave these results:

Material		Number of Apples	Percent Free from Stings
Lead arsenate	4 pounds	2063	89.63
DDT	1 pound		
Lead arsenate	2 pounds	1472	78.47
DDT	1 pound		
Lead arsenate	4 pounds	1231	60.44
Unsprayed		173	4.62

**Apple Maggot Emergence.** (W. D. Whitcomb, Waltham.) The emergence of apple maggot flies in orchard cages at Waltham occurred at about the normal time although the first fly was not recovered until July 1, about two weeks later than in the early season of 1944. The peak of emergence occurred on July 18.

	Orchard Cage
First Fly Emerged.....	July 1
25 percent of flies emerged.....	July 8
50 percent of flies emerged.....	July 15
75 percent of flies emerged.....	July 19
Last fly emerged.....	August 5
Percent of maggots which transformed.....	42.66

**Control of the Squash Vine Borer.** (W. D. Whitcomb, Waltham.) Further tests of the susceptibility of varieties of *Cucurbitaceae* indicated that all varieties of *Cucurbita moschata* are immune to attack by the squash vine borer. In 1945 no infestation was found in the Cushaw, Longfellow Pumpkin, Alagold, Large Cheese Pumpkin, Tennessee Sweet Potato, and Butternut varieties, all of which belong to the species *moschata*. The infestation in four species of *C. maxima* averaged 5.45 borers per vine, and in six species of *C. pepo* 3.47 borers per vine. Cucumber, cantaloupe, and watermelon were also immune to attack by this pest.

**Biology and Control of the Celery Plant Bug.** (W. D. Whitcomb and Wm. Garland, Waltham.) Unfavorable weather conditions in May and early June reduced the first generation of the celery plant bug, *Lygus campestris* L., to a minimum and the results of experimental field studies were insignificant.

The second generation was moderately abundant and caused severe injury in the form of "black heart" to all of the untreated plants of the second planting of celery. In the field where untreated celery was infested with 12 to 70 bugs per 10 plants, DDT-talc dust (containing 3 percent and 5 percent DDT) prevented reinfestation for 33 days; and sabadilla-lime dust (containing both 20 percent and 50 percent sabadilla seed) gave protection for 14 to 19 days. These treatments produced 70 to 80 percent marketable plants which were free of black heart at harvest. Dusts containing pyrethrum and rotenone killed the celery plant bugs but permitted reinfestation after 5 to 7 days.

**Biology and Control of the Grape Cane Girdler.** (W. D. Whitcomb and Wm. Garland, Waltham.) In laboratory insecticide experiments, none of the canes sprayed with DDT was girdled, and no eggs were laid on them. Beetles confined with DDT-sprayed canes lived about half as long as those confined with canes sprayed with lead arsenate and cryolite. The number of feeding scars was reduced proportionately. The use of freshly cut terminal grape canes in cages greatly simplified this type of insectary studies, compared with the potted grape vines which were used previously.

**Sprays to Prevent Scolytid Infestation of Elm Logs.** (W. B. Becker.) At Springfield, the following spray mixtures were applied once to the entire bark surface of elm logs before scolytids could attack them in the spring. The logs used in the different tests were up to 8 and 14 inches in diameter with bark up to one half and one inch thick. The percentages of prevention of scolytid infestation are based on the number of exit holes per square foot of bark in the late fall as compared with unsprayed logs. *Scolytus multistriatus* Marsham was the only or the predominant scolytid in the logs. The figures in parenthesis following each spray mixture indicate the proportion of ingredients and the amount of spray applied per square foot of bark.

	Percent Prevention
Gesarol A-20 (20% DDT wettable powder) and water (18 grams—3785 cc., 195 cc.).....	90.3
Gesarol emulsion (20% DDT) and water (1-400, 185 cc.).....	84.0
(1-200, 179 cc.).....	94.5
Kerosene alone (135 cc.).....	98.8
Used crankcase oil alone (169 cc.).....	94.6
No. 2 fuel oil alone (42 cc.).....	86.1
(123 cc.).....	100.0
(166 cc.).....	99.2
(213 cc.).....	100.0
Orthodichlorobenzene and No. 2 fuel oil (1-4, 113 cc.).....	100.0
(1-8, 54 cc.).....	96.7
(1-8, 115 cc.).....	100.0
(1-8, 132 cc.).....	100.0
(1-12, 105 cc.).....	98.0
(1-16, 107 cc.).....	99.1

At the same location other elm logs were sprayed six times at three-week intervals beginning May 31, with the following results. The proportions and amounts of spray indicated were used for each application.

	Percent Prevention
No. 2 fuel oil alone (176 cc.).....	100.0
Gesarol A-20 and water (18 grams - 3785 cc., 164 cc.).....	84.2
Gesarol emulsion and water (1-400, 164 cc.).....	87.1
(1-200, 158 cc.).....	90.3

**Sprays to Kill Scolytids Breeding in Elm Logs.** (W. B. Becker.) At Springfield, the following spray mixtures were applied on July 20 to the entire bark surface of scolytid-infested elm logs up to 6 and 10 inches in diameter with bark up to one half and three quarters inch thick in the different tests. The percentages of control are based on the number of exit holes per brood gallery in the late fall compared with those in unsprayed logs. Brood galleries of *Scolytus multistriatus* Marsham were more abundant than those of *Hylurgopinus rufipes* (Eich.) in these logs. The figures in parenthesis following each spray mixture indicate the proportion of ingredients and the amount of spray applied per square foot of bark.

	Present Control
Creosote and kerosene, strained (1-4, 189 cc.).....	96.5
Orthodichlorobenzene and No. 2 fuel oil (1-8, 208 cc.).....	91.7
No. 2 fuel oil alone (200 cc.).....	69.8
Kerosene alone (186 cc.).....	59.6
Gesarol emulsion (20% DDT) and water (1-400, 150 cc.).....	4.6
(1-200, 133 cc.).....	2.3
Gesarol A-20 (20% DDT wettable powder) and water (18 grams - 3785 cc., 181 cc.).....	0.0



At the same location other elm logs were sprayed four times at three-week intervals beginning July 20, with the following results. The proportions and amounts of spray materials indicated were used for each application.

	Present Control
Gesarol emulsion and water	
(1-400, 182 cc.) .....	52.9
(1-200, 145 cc.) .....	2.6
Gesarol A-20 and water (18 grams - 3785 cc., 172 cc.) .....	0.0

Although no significant reduction in the number of exit holes resulted from these DDT sprays, dead adults were occasionally found in the exit holes on some of the infested logs which were sprayed one or more times with DDT. This phenomenon was apparently not common enough in the logs sprayed with the other materials to have been noticed. To what extent the DDT residue on the surface of the bark may have affected beetles which completely emerged, was not determined.

**The Control of Elm Scolytid Infestation by Solar Heat.** (W. B. Becker.) Scolytid development in elm logs, up to 16 inches in diameter with bark up to 1 inch thick, piled in partial shade and left undisturbed until late October, served as a basis with which to compare the results of the several treatments. Percentages of control are based on the number of exit holes and unemerged survivors per square foot of bark.

Merely spreading uninfested logs, up to 19 inches in diameter with bark up to 1½ inches thick, singly in a north-south position in the sun on May 25 and leaving them undisturbed until late October resulted in 63.2 percent control. The upper half of the logs in the sun was free of brood galleries, except for a few almost half way down the sides of the logs (1.9 galleries compared with 7.1 per square foot scattered over the entire upper half of the control logs). On the lower half of the logs the number of brood galleries approximately equaled those in the control logs (15.3 compared with 14.5 per square foot); however, less than half as many exit holes and unemerged survivors were found there (45.7 compared with 94.6 per square foot in the controls). Both in these logs and in the control logs piled in partial shade, brood galleries of *Scolytus multistriatus* Marsham and *Hylurgopinus rufipes* (Eich.) were almost equally abundant.

When logs up to 16 inches in diameter with bark up to 1 inch thick were similarly placed in the sun on May 25, but turned over on July 12 after the lower portion had become infested, 79.6 percent control resulted.

Other logs with diameters up to 23 inches and bark up to 1 inch thick were piled in the shade from May 25 to July 12, by which time they were well infested with scolytids. On the latter date they were spread singly in the sun in a north-south position, and on August 2 they were turned over. This resulted in 95 percent control.

When logs up to 24 inches in diameter with bark up to 1¾ inches thick were spread singly north and south in the sun on May 25, turned over every week through August 17, and then left undisturbed until late October, 99.7 percent prevention of infestation resulted. Logs up to 23 inches in diameter with bark up to 1½ inches thick, which were turned in the sun every two weeks during the same period showed 98.8 percent prevention, while other logs up to 24 inches in diameter with bark up to 1½ inches thick showed 98.7 percent prevention.

When logs up to 17 inches in diameter with bark up to 1 inch thick were spread singly north and south in the sun on May 25 and sprayed on the lower half with creosote and kerosene, strained (1 to 4 by volume), over 99.9 percent prevention resulted.

## DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

**Breeding Snapdragons for Variety Improvement and Disease Resistance.** (Harold E. White, Waltham.) The Helen Tobin snapdragon, a recent introduction of the Waltham Field Station, has been grown by florists in 24 different states, north as far as Bar Harbor, Maine, and south as far as Texas and Florida, and requests for seed for trial have been received from foreign countries. Many growers reported this variety as excellent in performance and regarded it as unusual in size, color of flowers, and habit of growth, and several reported it as an excellent variety for their locality.

As with any new variety of plant material, certain characters need to be improved. Therefore, commercial winter-flowering varieties of snapdragon have been crossed with Helen Tobin to obtain a wider range of flower colors. A seedling mutation of Helen Tobin, which is of a darker pink color, gives promise of improvement over the present variety and is being selected for further trial. Seed stocks of a number of first generation hybrids of snapdragons and unnamed selfed lines are being increased so that more extensive trials can be made to determine their adaptability for commercial use.

**Disease Resistance and Heredity of Carnations.** (Harold E. White, Waltham.) Hybridizing of commercial varieties of carnations is being continued. To date, seed production from crosses has been very low; hence large populations from individual crosses, sufficient for a thorough study of disease resistance, have not been obtained. Selections have been made from a number of seedlings from previous crosses, but these do not offer enough variability for reliable conclusions. Cultural treatments and methods of inducing more abundant seed production from carnation plants are being investigated.

**Subirrigation Methods of Watering Carnations.** (Harold E. White, Waltham.) The four raised concrete V-bottom benches and two ground beds, which were constructed at the Waltham Field Station in 1945 for subirrigation studies on florists' crops, were operated with carnations. Half the benches and beds were subirrigated and the remainder were top-watered in the customary manner. The plants made excellent growth under both systems. During the early fall, plants in the subirrigated benches appeared to be somewhat more advanced in growth than the top-watered; but as the season progressed, this difference became less perceptible.

The number of blossoms cut from subirrigated and top-watered plants was not significantly different. Keeping quality, size of flowers, and length of stems were equally good. Frequency of watering was reduced 50 percent by subirrigation methods as compared to the practice of top watering.

The chief advantage of subirrigation over surface watering is the reduction in frequency of watering, which under greenhouse conditions is a considerable item of expense in growing crops. Other important features are more uniform moisture conditions, better aeration of soils, conservation of plant food elements, and less danger from air-borne fungous diseases.

Subirrigation methods of watering greenhouse crops by flooding, measured injection of given quantities, constant water level, and automatic regulation are worthy of any grower's consideration. One system may be better adapted for one grower's needs than another, but there is plenty of opportunity for modification of existing methods. Automatic regulation and constant water level methods of watering are being put into operation for observation.

**Treatment of Sand with Fermate for Carnation Cuttings.** (Harold E. White, Waltham.) Propagating sand for use in rooting carnation cuttings was treated with dry Fermate (ferric dimethyldithiocarbamate) at the rate of 2 pounds and 3 pounds per 100 square feet. Cuttings from 12 varieties of carnations were placed in treated and untreated sand. The increase in percentage of rooting of carnation cuttings in Fermate-treated sand over untreated sand was quite variable. Eleven lots of cuttings showed increases in percentage of cuttings rooted, from as low as 1 percent to as high as 25, and six lots showed a decrease in comparison with untreated. The difference in percentage of cuttings rooted in the 2-pound and 3-pound treatments was equally variable. Rooting response to the same treatment varied with varieties of cuttings. When cuttings of a particular variety rooted poorly with no treatment, the response was poor with the Fermate treatment.

The results obtained in these tests indicate that Fermate applied directly to the sand is of no particular value for rooting of carnation cuttings. Losses from rot diseases in the cuttings were not sufficient to determine whether such treatments are effective as a means of disease control.

**Sodium Selenate as a Red Spider Control.** (Harold E. White, Waltham.) In tests at Waltham, the application of sodium selenate to soils in which carnations are growing has proved to be an effective means of controlling red spider. Experiments were conducted on plants grown in pots, flats, and benches. Observations were also made on plantings of treated carnations in local greenhouse ranges. Young carnation plants in flats remained free of red spider for 5 to 6 months after one application of sodium selenate to the soil in early spring. In benches, treatments made in July kept the carnations free of red spider for 10 months, whereas untreated plants became heavily infested.

Two forms of sodium selenate were used in the tests, pure selenate ( $\text{NaSeO}_2$ ) and a commercial product known as P-40, which is superphosphate impregnated with 2 percent of sodium selenate. The pure sodium selenate was dissolved in water at the rate of 100 grams per gallon, to make a stock solution; each quart of stock solution was diluted with 25 gallons of water; and 1 quart of diluted solution was applied to 1 square foot of soil. At this rate each square foot received  $\frac{1}{4}$  gram of sodium selenate. The P-40 was applied to the soil at the rate of 3, 4, and 6 pounds per 100 square feet. At these dosages red spider was effectively controlled. Although no injury to carnations was observed from the dosage of 6 pounds, a minimum rate of 3 to 4 pounds per 100 square feet was sufficient for good control. At the rate of 3 pounds of P-40 per 100 square feet, each square foot received  $\frac{1}{4}$  gram of sodium selenate.

Carnation plants should be treated with sodium selenate after they are established in the soil, and at least 4 weeks must be allowed for the effect of the treatment to show. Some preliminary tests at Waltham indicated that pre-treatment of the soil with sodium selenate at the rate of  $\frac{1}{4}$  gram per square foot, 6 weeks prior to planting, may be a safe procedure.

Variations in soil conditions and other factors may affect the results obtained with sodium selenate. Young, actively growing plants have been observed to respond more readily to selenate treatment than older plants. Conditions which affect movement of water into the plants are also limiting factors.



## DEPARTMENT OF FOOD TECHNOLOGY

C. R. Fellers in Charge

**The Use of Calcium Salts in Freezing McIntosh Apples.** (W. B. Esselen, Jr., J. J. Powers, and C. R. Fellers.) In Massachusetts and throughout New England the McIntosh apple is by far the most important commercial variety. Unfortunately, this apple as grown in Massachusetts and certain other areas is usually of rather soft texture, especially after storage, and is not well adapted to freezing, canning, or bakery use. When processed by these methods the sliced apples tend to become very soft and mushy, particularly when used in pies.



UPPER: Pies Made from Fresh McIntosh Apples.

No. 10—Control

No. 12—Sliced apples treated with calcium

LOWER: Pies Made from Frozen McIntosh Apples.

No. 7—Control

No. 5—Sliced apples treated with calcium before being frozen

Experiments have been carried on during the past year with methods for increasing the firmness of sliced Massachusetts-grown McIntosh apples in order to maintain their shape during canning, freezing, and baking. The use of calcium as a firming agent is quite effective for this purpose. The amount of calcium used (such as calcium chloride) and the time of the treatment will vary depending upon such factors as the original firmness of the apples, the length of time they have been in storage, the degree of firmness desired, etc. Concentrations of from 0.03 to 1.50 percent calcium in the treating solution may be indicated depending upon the processing method and the condition of the apples. These calcium treatment have been found to be just as effective with so-called "green McIntosh" apples as with ordinary McIntosh.

**Stability of Riboflavin in Processed Foods.** (W. B. Esselen, Jr., A. Filios, J. Crimmins, M. W. Paparella, and M. S. Gutowska.) An investigation of the stability of riboflavin in a large number of commercially canned foods, packed in glass or metal containers is being carried on. Many different kinds of baby foods are included among the products considered. There appears to be considerable variation in the stability of riboflavin in different products, regardless of the type of container in which they are packed. The loss of riboflavin during three months' exposure to diffused daylight on a typical store shelf varied from 0.0 to 60.0 percent, depending upon the products. Such products as strained peas, liver soup, chopped spinach, vegetables and liver, red kidney beans, chopped prunes, strained and chopped beets, and chopped carrots showed only small losses; while products such as strained green beans, custard pudding, tomato juice, strained peaches, and strained tomato porridge showed greater losses. These losses tended to increase during storage for 12 months. In some cases losses, but not as great as those in samples exposed to the light, were found in both glass and tin packed products stored in the dark and at different temperatures.

To date the results show that in many glass-packed foods the loss of riboflavin during storage on a store shelf under normal conditions would be small. The results of the present investigation are in general agreement with an earlier preliminary study made with glass and tin packed asparagus, peas, corn, and green beans and show that riboflavin seems to be less stable in the more acid products.

**Ascorbic Acids as Antioxidants.** (C. R. Fellers, J. E. W. McConnell, J. J. Powers, W. B. Esselen, Jr., L. R. Parkinson, and G. S. Congdon.) In 1940 this department demonstrated that l-ascorbic acid (vitamin C) was an effective antioxidant in preventing surface darkening in home-canned fruits. As a result of this and later work carried on here and elsewhere, ascorbic acid is now recognized as an important antioxidant in the food industries. Today it is being used in such things as home-canned and frozen fruits, commercial frozen fruits, particularly peaches, apple juice, and certain beverages.

During the past year a study has been made of the antioxidant properties of a new ascorbic acid compound, 5, 6 diacetyl-l-ascorbic acid, which holds promise of being adapted to use where a slower-acting antioxidant is indicated. The rate of oxidation was found to be considerably slower than that of l-ascorbic acid or d-iso ascorbic acid during storage in a bottled buffered aqueous solution at pH 4.0. On an equivalent weight basis the biological vitamin C activity of 5,6 diacetyl-l-ascorbic acid was comparable with that of l-ascorbic acid as determined by guinea pig bioassay.

Further uses of ascorbic acid as antioxidants are being investigated.

There is considerable interest at present in the fortification of such juices as apple, cranberry, and grape with ascorbic acid to put them on a par with citrus

juices as sources of vitamin C. In some juices such as apple, the added ascorbic acid also serves as an effective antioxidant in preventing color and flavor changes. During the past three years, a number of tests have been made to determine the stability of added ascorbic acid in glass-packed apple, cranberry, and grape juices. In all cases the ascorbic acid was well retained during processing and storage. It is recommended that ascorbic acid, if used under commercial conditions to fortify bottled fruit juices normally low in vitamin C, be added on a basis of 50 milligrams per 100 milliliters or 190 grams per 100 gallons of juice. If the ascorbic acid is added as an antioxidant only, 75 grams per 100 gallons of juice should be adequate.

**Glass-Packed Citrus Juices.** (W. B. Esselen, Jr., J. E. W. McConnell, C. R. Fellers, and A. S. Levine.) Experimental test packs of bottled grapefruit and orange juices, packed in a commercial plant in Florida, have been obtained in order to study the effect of added antioxidants and storage temperatures on the quality of these products. The addition of d-iso ascorbic acid or l-ascorbic acid to bottled citrus juices seemed to have a definite favorable effect on flavor retention during storage, but was not effective in preventing darkening under adverse storage conditions—tended, in fact, to accentuate it, as has been previously reported from this laboratory. Samples of the grapefruit and orange juices have been stored at temperatures of 35°, 50°–60°, 70°–80°, and 100° F. for periods up to a year. It is recommended that glass-packed citrus juices be held at temperatures of 60° F. or lower during storage. Under these conditions the original flavor of the juices is well retained. At temperatures of 70°–80°, the storage life of glass-packed citrus juices is approximately six months.

**Effect of Carbon Dioxide Gas on Color Retention in Citrus Juices.** (W. B. Esselen, Jr., G. S. Congdon, and J. E. W. McConnell.) Laboratory tests have shown that if grapefruit and orange juices are saturated with carbon dioxide gas prior to pasteurization and bottling, their tendency to darken during storage is decreased. In accelerated tests the storage life of these juices (based on tendency to darken) was extended from four to six times. These findings are being checked with packs of juices put up under commercial conditions.

**Home Canning Research.** (W. B. Esselen, Jr., G. Lycarczyk, N. Glazier, J. E. W. McConnell, A. S. Levine, C. R. Fellers.) A comparison of time and fuel consumption was made to determine the relative efficiency of the pressure canner and water bath methods of processing for acid foods. For the urban home canner the use of a pressure canner operated at 0 to 1 pound steam pressure in place of the water bath resulted in an approximate saving of 25 percent in total time required and in fuel consumption. Recommended boiling water bath process times were used in both cases.

Excessively rapid cooling at the end of processing is an important cause of loss from home canning jars; fluctuations in pressure during processing a less important cause. Jars sealed with the zinc Mason cap and the partially sealed bail-type jars showed the greatest loss of liquid. The two-piece metal lid, three-piece glass lid, and fully sealed bail-type jars exhibited a minimum loss of liquid. The number of jars being processed, the nature of the product (slow or fast heating), and the size of the pressure canner were found to have a significant effect on the come-up and cooling times of different pressure canners.

It is frequently stated that the presence of decayed vegetables in the canned product decreases the acidity so that it is more difficult to sterilize the product. Studies have been carried out with different vegetables in which various proportions of sound and decayed product were canned. It was found that the presence of decayed peas, beans, and greens, particularly, might decrease the acidity of the jar contents to a point where a longer process time would be required.



New home canning jars, as purchased, were found to be relatively free of bacteria compared with jars which had been used and then stored for use the following season. These findings point to the desirability of thoroughly washing home canning jars after they have been emptied and before they are put away, and of washing them in hot soapy water prior to use the following season.

**Investigation of Processing Methods for Home Canned Fruits.** (Cooperative project with the Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture.) (J. E. W. McConnell, W. B. Esselen, Jr., D. Anderson, I. Powers, F. Johnson, and M. Mrowkowski.) During the summer of 1945, heat penetration and processing data were obtained for home-canned rhubarb, strawberries, cherries, raspberries, blueberries, peaches, apple sauce, tomatoes, and tomato juice. In most cases the data were obtained on the products packed in both pint and quart jars and processed in a boiling water bath and in a steam pressure canner at 1, 5, and 10 pounds steam pressure. The initial temperature is important in processing home-canned fruits because of the lethal rate of the micro-organisms concerned, the rate of heat penetration into the product, and the short process time usually employed. Processing at 1 pound steam pressure in a pressure canner was found to be similar in sterilizing value and heating rate of products to processing in a boiling water bath. Any slight differences were in favor of the pressure canner.

**Home Freezing.** (A. S. Levine, W. B. Esselen, Jr., K. M. Lawler, N. Glazier and C. R. Fellers.) An investigation of the suitability of different varieties of fruits and vegetables, as grown in Massachusetts, for freezing is being continued. Samples of raw material for freezing have been obtained through the cooperation of the Olericulture and Pomology Departments. A survey and study have also been made in an effort to ascertain the role and importance of home freezing in Massachusetts. This study has included a suggested freezing program based on Massachusetts products, the economic aspects of freezing certain products, home freezing costs, and a comparison of freezing and canning as methods of home food preservation.

Since relatively little meat is raised in Massachusetts it is questionable whether the freezing of meat is practical. At the present time there is considerable interest in this subject as a means of having meat on hand when the supply is short; but under ordinary conditions meat may be purchased as needed. With the large number of poultry flocks in Massachusetts, poultry may well be frozen.

It has been suggested that such foods as eggs, lard, butter, and citrus juices may be purchased when the price is low and frozen in sufficient quantities to be used throughout the year. It would appear, however, that the saving which results is completely offset by the cost of packaging and of the freezing storage and by the amount of space required in the home freezing unit.

The rental of a freezer locker is definitely less expensive than an equivalent amount of freezer capacity in the form of a home freezer, but is also less convenient. Home freezing is definitely more expensive than home canning. On a basis of equipment cost and depreciation, power, containers, and storage, the unit cost of preserving food by freezing is four to five times that of canning. With good management the freezing cost may be reduced somewhat.

Home freezing is a particularly good method of preservation for strawberries, raspberries, broccoli, greens, corn, and meats. On a basis of quality such products as tomatoes and tomato juice, green beans, carrots, beets, and peaches can be preserved equally well, if not better, by canning, as shown by comparative tests carried out during the past three years.

All things considered, home freezing in Massachusetts does not appear to be as important as it may prove to be in certain other sections of the country. It would appear that home freezing may be best used to supplement rather than to replace other methods of home food preservation.

**Vitamin D Investigations.** (L. R. Parkinson and C. R. Fellers.) Periodic checks were made on the vitamin D content of Vitamin D milks sold in New England. These assays showed that of the 192 samples examined, 181 contained at least 400 U.S.P. units per quart, 8 samples contained from 320-400 units, and only 3 samples were seriously deficient. Direct irradiation of milk is no longer practiced in this State. The principal means of adding vitamin D to milk is by direct addition of irradiated or activated ergosterol or purified fish oil concentrate.

## DEPARTMENT OF HOME ECONOMICS NUTRITION

Julia O. Holmes in Charge

**Utilization of Iron in Foods. 1. By Human Subjects.** (B. V. McKey, A. W. Wertz, D. C. Staples, and J. O. Holmes.) Four healthy women ranging in age from 24 to 37 years participated as subjects of the experiment. During the four and one half months of the study they received a basal diet which contained only 3.8 mg. of iron (about one-third of the amount recommended by the National Research Council as a daily allowance for women), but was adequate in all other respects. Beef muscle, approximately one fifth of a pound daily, was fed in addition to the basal diet from the 65th to the 115th day of the experiment; and iron sulfate, an iron salt frequently recommended by physicians as a source of iron, was fed in a quantity equivalent to the iron in the beef, from the 116th to the 130th day. During the experiment the four subjects donated approximately 1 pint of blood on the 1st, 15th, and 95th days, in an attempt to induce a mild state of anemia which would insure maximal use of the iron in the foods.

An anemia of clinical severity was not produced in any of the subjects. Following the second withdrawal of blood, the hemoglobin in only two of the subjects fell as low as 90 percent of that usually found in normal, healthy young women. Throughout the experiment the subjects were cheerful, energetic, and felt well. The absorption of iron was as follows:

	Percentage Absorption of Iron by the four subjects			
In the basal diet.....	0	3	14	23
In the beef alone.....	19	44	51	36
In the iron sulfate alone.....	0	26	37	19

The woman who utilized the least iron in each of the diets was one who had been severely anemic the preceding summer and had received iron medication under a physician's prescription. It is probable that she made such poor use of iron during the experiment because her body tissues were so saturated with iron that the withdrawal of blood did not reduce her iron stores enough to allow for absorption of new iron. The hemoglobin level of this subject after the second blood donation within a 15-day period approximated that found in normal, healthy non-donors of blood.

These data indicate that all four of the women made more efficient use of the iron in beef than in the iron salt. They also suggest that healthy women whose body tissues are filled with iron can donate blood in the amounts and with the frequency prescribed by the American Red Cross without serious depletion of their iron stores, provided their diet is adequate in protein, vitamins, and min-

erals. For continuous blood donation a level of iron higher than that used in this study would be advocated.

**2. By Rats.** (A. W. Wertz.) The problem of the availability of iron in foods was also studied with the use of the rat as the experimental animal. The foods studied were roast beef and boiled navy beans, both being fed in dry form. Iron sulfate was used as a standard for comparing the availability of iron in these foods. The animals received a basal ration of milk powder and were paired according to sex, weight, litter membership, and hemoglobin of the blood. The amount of iron fed in the supplement was 0.2 mg. per day; and the amount stored during the 35-day period while the rats were receiving the supplement was determined by analyzing the carcasses.

The rats receiving iron sulfate retained more iron than did their litter-mates receiving the beef or the bean supplements. When the availability of the iron sulfate was set at 100, the retention of iron approximated 60 for the cooked beef and about 90 for the dried beans. These preliminary data suggest that the iron in navy beans may be better utilized than the iron in beef. Contrary to the results obtained with human subjects, the iron sulfate appeared to be a better source of iron for the rat than did the cooked beef.

**Studies Relating to the Cause of Tooth Decay.** (Julia O. Holmes, L. R. Parkinson, A. W. Wertz, and B. V. McKey.) The hypothesis used in planning these studies has been (a) tooth decay is caused by the acid which is produced as a by-product of the growth of bacteria which flourish in the oral cavity, and, conversely, decay may be prevented by inhibiting the growth of these bacteria; (b) under certain dietary conditions the salivary glands secrete a substance, the anti-caries factor X, which prevents bacterial growth; (c) the factor X either is a constituent of certain foods or is manufactured in the body, possibly in the salivary glands, possibly by the bacteria in the digestive tract, from the substances contained in those foods.

During the year approximately 200 rats have been reared on the decay-producing diet consisting of coarsely ground corn, milk powder, and alfalfa meal, supplemented with various dietary factors in an attempt to find one which would prevent the rampant tooth decay consistently found in rats reared on this basal diet. These substances included beef muscle, liver, alfalfa, butter fat, yeast, a rice-bran extract, fluorine, the amino acid tryptophane, the vitamins nicotinic acid and K, a mixture of the fat-soluble vitamins, and a mixture of both the fat-soluble and the water-soluble vitamins in crystalline or concentrate form. Other groups of rats were reared on a "purified" diet consisting of casein, mineral mixture, a "complete" vitamin mixture, and either sucrose, dextrose, or cornstarch, to determine whether tooth decay can be induced in rats consuming diets which do not contain corn. A sulfa drug, succinyl sulfathiazole, was fed to groups of rats receiving (a) the corn diet in which the corn was cooked and (b) the purified diet in which the carbohydrate was starch, both of which had been found by other investigators to prevent tooth decay in the rat. The sulfa drug was given because of its "sterilizing" action in the bowel; the idea being that, if the bacteria of the bowel normally manufacture the factor X from substances in these two diets, the factor would not be made by the rats receiving the drug; hence these rats would experience more tooth decay than would be found in their litter-mates not receiving the drug.

None of the supplements fed in conjunction with the raw-corn diet caused even the slightest decrease in the rampant tooth decay observed on the basal corn diet, although some of them had been reported by other investigators as preventing tooth decay. These results led to the tentative conclusion that the



corn diet may produce decay, not because of its deficiency in factor X but because it contains some deleterious substance which either unites with factor X thus making it unavailable, or makes impossible the synthesis of factor X. Unexpectedly, tooth decay was present in an advanced state in the rats receiving the cooked-corn diet, although the incidence and extent of decay were not as great as on the raw-corn diets. This led to the conclusion that corn causes decay in the rat, not because of the hardness of the particle but because of some fundamental constituent either in the corn or lacking in the corn. If corn contains a deleterious substance, it is not found in the starch fraction of the corn, since rats fed the purified diet containing cornstarch did not experience tooth decay.

The replacement of cornstarch by cane or corn sugars in the purified diets resulted in a mild degree of decay on the grinding surfaces of the teeth. This is the first report of such a finding in the albino rat fed purified diets, although it has previously been reported that the cotton rat develops tooth decay when subjected to diets containing soluble carbohydrates. The fact that the soluble carbohydrates when fed in large quantity allow tooth decay might tempt one to conclude that the sugars are the sole cause of decay. Such a conclusion must be abandoned, however, in view of the rampant decay found in rats fed corn diets, which contain only a small amount of soluble carbohydrate—the lactose in the milk powder.

The sulfa drug did not increase the incidence or extent of decay over that found in litter-mates receiving the diet without the drug. None of the rats receiving the purified diets showed decay even though they received the sulfa drug. Likewise the cooked-corn diet plus the sulfa drug was not any more conducive to decay than the diet without the drug. These findings suggest that either factor X is not manufactured by the bacteria in the bowel, or the sulfa drug in the dosage administered does not prevent the growth of the strain of bacteria responsible for its manufacture.

Although the year's work has not resulted in data which confirm or refute the hypothesis used in planning these experiments, the study will be continued.

**The Role of Calcium in the Calcification of Bones.** (Marie S. Gutowska and Julia O. Holmes.) In a preliminary study of the influence of environmental temperature on calcium metabolism, growing rats held at 62°F. consumed approximately twice as much food as did litter-mates held at 87°. On analyzing the carcasses of the rats, more calcium was found in those held at the cold temperature and it was concluded that the cold temperature stimulated the storage of calcium in the rat. However, since the animals in the cold environment consumed twice as much food as those in the warm, and since the percentage of calcium in the ration was identical for both groups, it is obvious that the animals in the cold environment consumed twice as much calcium. Consequently the results obtained might have been due to differences in quantity of calcium consumed rather than to differences in environmental temperature. In order to distinguish between these two variables, temperature and quantity of food eaten, a system of feeding was devised whereby the animals of two groups would receive equal quantities of calcium but would be allowed to eat as much of the calcium-free basal food as was necessary to satisfy individual needs.

In Series 1, two litter-mate groups of animals, one held at 62°F. and the other at 87°F., were fed a diet containing 0.6 percent calcium. All were allowed to eat as much as they desired. In Series 2, three litter-mate rats were fed a small portion of calcium in a fixed daily quantity separate from the ration, which was devoid of calcium. One rat was allowed to eat as much of the calcium-free food as he desired, the second was allowed only three fourths as much food as the first, and the third was allowed only half as much as the first. In Series 3, two

groups were fed the same diet devoid of calcium, one being kept at 62° and the other at 87°. These animals were allowed to eat as much of the calcium-free food as they wished, but all were given an identical quantity of calcium separate from the ration. In all three series the animals were of the same age and were fed and cared for in the same way.

In Series 1, the quantity of ash stored by the animals was dependent on the quantity of food eaten; those eating the smaller amount of food had the smaller amount of ash in their bones, whereas those eating more food had the greater amount of ash. In contrast, the rats in Series 2 stored almost identical quantities of ash in their bones, irrespective of the quantity of food eaten. In Series 3, the rats reared at 62°F. had no more ash in their bones than did their litter-mates reared at 87°.

These results show the importance of controlling the intake of calcium in studies which are concerned with the growth and calcification of the skeleton.

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## DEPARTMENT OF HORTICULTURE

R. A. Van Meter in Charge

**Study of Herbaceous Perennial Material.** (C. J. Gilgut, Waltham.) The perennial test garden with its extensive collection of labeled plants is the only one of its kind in New England. It is of value to nurserymen, landscape architects, students, and the gardening public, who wish to observe and study the response of various plants to our local climatic conditions. At present, it contains about 2500 plants, many of which are old garden favorites. There are also many new varieties, recently introduced into the trade, and some placed here by a number of hybridists, for comment and report as to garden value, cultural requirements, and winter hardiness.

Probably more new varieties of the so-called hardy chrysanthemum are being developed and introduced today than of any other garden flower. The collection here includes many, but not all, of the better introductions of the Korean hybrids from Bristol Nurseries, and the hybrids from the University of Minnesota, University of Chicago, University of New Hampshire, Colprit Nurseries, and the United States Department of Agriculture. Although these chrysanthemums are considered hardy, they have not been found reliably so in the test garden and it has been found necessary to resort to wintering them in cold frames to insure against loss by winterkilling.

The extensive collection of tall bearded iris suffered considerably from winter injury, which was followed by much soft rot of the older rhizomes, in spite of a mild winter and a good blanket of snow. There was more loss in the recently transplanted iris than in those established for a year or more. Mulching the first winter after transplanting might have prevented much of this loss.

**Factors Influencing the Rapidity of Growth of Nursery Stock.** (C. J. Gilgut, Waltham.) In a propagating medium of sand-peat in which a previous batch of cuttings had rotted badly, several materials commonly recommended for sterilizing media were tried. The dry chemicals were scattered over the sand-peat, and the formaldehyde sprinkled on with a watering pot. Each was then thoroughly worked into the medium and cuttings of *Taxus media hatfeldi* were inserted. The materials used and the effect on rooting of cuttings are shown below.

Material	Amount per Square Foot	Percentage of Cuttings Rooted	
		In 9 Weeks	In 20 Weeks
Untreated.....			92
Formaldehyde.....	2.5 cc.	88	93
Potassium permanganate.....	7 grams	86	95
Fermate.....	28 grams	6	70
Spergon.....	14 grams	12	50

Rooting was quicker and better with the formaldehyde and potassium permanganate treatments than in the untreated medium. Fermate and Spergon prevented rot, but had a decidedly retarding effect on rooting. Apparently, when propagating media are to be used again, the preferred treatment is either formaldehyde or potassium permanganate.

In a comparison of the root-promoting substances, Hormodin No. 2 and Hormodin No. 3, in used sand treated with formaldehyde 2.5 cc. per square foot or with potassium permanganate 7 grams per square foot, better and quicker rooting was obtained with Hormodin No. 2. In the formaldehyde-treated sand Hormodin No. 2 gave 96 percent rooted in 10 weeks, against 80 percent for No. 3. In the sand treated with potassium permanganate, the percentage rooting in 10 weeks was 96 for Hormodin No. 2 against 86 for No. 3.

**Control of Weeds in the Nursery by Chemical Sprays.** (C. J. Gilgut, Waltham.) During the past season, Savasol No. 5, one of the oils which has found such a definite place in the commercial growing of carrots and parsnips, was investigated for control of weeds in the nursery. Nearly all the common weeds were quickly killed, especially when they were small. A few, notably ragweed (*Ambrosia artemisiifolia* L.), wild chamomile (*Matricaria suaveolens* (Pursh) Buchenau), and fleabane (*Erigeron canadensis* L.), all of which are in the family Compositae, were highly resistant to the oil and both young and old plants usually survived even thorough soakings.

Applications of undiluted oil were made with a 4-gallon sprayer equipped with a Skinner greenhouse irrigation nozzle, ST 50, which gives a flat fan-shaped spray. A flat spray is better than a cone-shaped for it wets the weeds better and is more easily controlled so that less oil gets on the nursery plants. The spray was directed at the weeds, and in the case of tall nursery plants the lower foliage of these plants was also wet. With the smaller nursery stock, it was necessary to wet the entire plant in order to wet the weeds.

On hemlock there was no injury to the older leaves, and slight injury to the soft, tender new needles but not enough to retard growth. Arbor vitae was likewise highly resistant, and young plants 12-15 inches tall showed only slight yellowing of foliage. Norway spruce and Colorado blue spruce, as well as white pine and Scotch pine, showed little or no injury. The most tolerant of all the evergreens tested was *Juniperus virginiana glauca*, which showed only a slight yellowing of some of the needles and no bark injury when sprayed much more heavily than is needed to kill weeds.

On *Taxus* spp. the spray injured the leaves and caused considerable defoliation as well as some bark injury, and it definitely is not safe on this group of plants. In general, on broad-leaf plants, evergreen and deciduous, there was considerable injury to the leaves, and to the bark in many cases if wet to any extent.

Although most of the narrow-leaf evergreens are highly tolerant to Savasol No. 5; as with other chemical sprays, caution should be used that too much spray does not get onto the plants. A careful operator, using a flat fan-shaped spray, can kill weeds close to the plants in a nursery row quickly and efficiently with a minimum of injury to the stock.



## DEPARTMENT OF OLERICULTURE

G. B. Snyder in Charge

**Asparagus Investigations.** (Robert E. Young, Waltham.) Growing conditions of the two preceding years reduced the 1945 asparagus crop at the Waltham Field Station to 56 percent of the 1944 crop. A reduction of 10 to 20 percent in the stalk count taken in the fall of 1944 was due to the unfavorable weather during the growing season. Selections Nos. 1 and 4 have yielded almost twice as many spears as the commercial strain in the past; and even though the total yields were greatly reduced, this ratio was about the same in 1945. The average weight of spears was only slightly less than previously, and most of the reduction was in the number of stalks. There was no change in the percentage of the two top grades as compared with 1944.

In the spring of 1945 a new generation of roots was set. Besides several commercial varieties, these included many combinations of best male and female plants from the plantings mentioned above. To obtain information on inheritance of yield characteristics, portions of the same female plant were crossed with two or more male plants. Two low-yielding plants, one male and the other female, were also used in crosses. Nineteen different strains and varieties were planted in three replications. The plants made vigorous growth and only 19 out of 1900 died. It may be only a coincidence that 7 of these were from one of the commercial strains. Those that died were not the small ones; in fact the average weight of these crowns was greater than the average for the entire lot of plants, which was 58 grams.

In the fall a count was made of the number of stalks produced by each strain during the summer, and the average per plant varied from 5.11 to 14.41. The commercial varieties and those crosses involving one or more low-yielding parents produced the fewest stalks. Such a variation might be presumed to depend to a large extent upon the original weight of the crowns when planted, but the strain which produced the least stalks had the largest crowns. There was little or no correlation between the original weight of the crowns and the number of stalks produced. While the number of stalks an asparagus plant produces in the first year's growth is not a sure criterion of future yield, data on second-generation plants show that the production of a large number of stalks in the first year is correlated with future high yields.

**Vegetable Breeding for Improvement of Quality.** (Robert E. Young, Waltham.) During the year breeding work has been conducted with broccoli, greenhouse cucumber, celery, rutabaga, New York type lettuce, tomato, carrot, and Butternut squash. While progress has been made in the development of strains of carrot, celery, New York type lettuce, rutabaga, and greenhouse cucumber better adapted for local use, it is insufficient to justify detailed discussion.

**Broccoli.** Lack of uniformity in time of maturity and plant type in commercial varieties of broccoli was the reason for starting a breeding project on this crop. The variation in maturity of plants is demonstrated by two commercial varieties in our spring crop. By June 15, a date in midseason when all center heads should be ready if the crop is to be profitable, 41 percent of the plants from one of these varieties had been cut and 64 percent from the other. The best of the breeding lines set in the same field at the same time had produced 98 percent center heads. Other selfed lines ran from 47 to 93 percent, depending on the number of times selfed. This self-pollination has produced the desired uniformity in type and maturity but has reduced vigor and narrowed adaptability.

In order to produce a large supply of seed of one selfed strain, R-45, the plants were allowed to cross-pollinate among themselves. This massing improved vigor while maintaining uniformity. This strain, which was grown in a large block, proved to be the most outstanding broccoli ever grown here and had produced 89 percent of the center heads by June 15. It will be tested once more to be sure of its seasonal adaptability before being released to growers.

Results of this project indicate that while some strains are adaptable for both spring and fall crops, most are satisfactory only for the season for which they are bred. If the plants are self-pollinated more than two or three times, the loss of vigor is so great as to make them commercially worthless.

*Butternut Squash.* In 1943, local growers asked for a better, more uniform strain of Butternut squash. Trials of commercial and growers' strains indicated considerable variation, and some strains had a large percentage of the crop that was not marketable.

There was particular objection on the part of growers to cracking, crooked or curved fruit, and too great length. The breeding program is an attempt to combine the best of these characteristics in one strain. In 1945 the crop from the commercial strains varied from 0.6 percent to 12.8 percent crooked fruit, and from 19.4 to 42.9 percent cracking. No. 1 fruit—that is, squash of the desired size and shape and not cracked—varied from 227 to 345 boxes per acre.

During 1944, some of the best strains were self-pollinated, and these were grown during 1945. Some of the selfed lines possessed most of the characters desired and seemed quite uniform. The best of them had only 11 percent cracked, 6.7 percent crooked, 0.7 percent long, 7 percent small or misshapen; and a total yield of 520 boxes per acre. The yields from these lines varied from 407 to 607 boxes per acre, but the highest yielding strains had the greatest percentage of cull fruits, so the yield per acre of No. 1 fruit (not cracked) was only 394 boxes.

There is also the problem of obtaining a squash that will keep in storage and that does not shrink or shrivel. All the selfed squashes were placed in storage and weighed at intervals. The loss in weight from October 6 to December 19 was 12 to 14 percent, and the total loss to January 3 averaged 20 percent. These figures represent shrinkage only and do not include loss by rots. Unless a means can be found to reduce the shrinkage, the Butternut squash cannot be stored economically. Careful handling from field to storage is very important in the prevention of loss in storage.

In some tests to determine the carotene content and its relation to color of flesh, it was found that a dark color of flesh was not always an indication of high carotene. One lighter-colored squash had 2.14 milligrams carotene per 100 grams, which was next to the highest carotene content found.

In some preliminary trials on spacing Butternut squash, the number of fruits per plant increased with the increase in space, as follows: 6 x 6 feet, 1.90; 8 x 8 feet, 3.04; 10 x 10 feet, 3.87; and 12 x 12 feet, 5.92. There was very little difference in the average weight of the squash. While these trials were not replicated and were on a poor part of the field, the total yields per acre did not vary much from one spacing to another. It seems, therefore, that Butternut squash can be grown at spacings of 10 to 12 feet with satisfactory results.

*Trellis Tomatoes.* Trials of several varieties and strains of tomatoes were conducted. During the early part of the growing season of 1945 the weather was cold and wet and not conducive to good setting of fruit on the first hand or blossom cluster. In early July counts were made to determine whether there was any variation in set among varieties and strains. One variety had set an average of only 0.5 fruit per first cluster while another had set 3.7 fruits. Some

varieties the percentage of set was: Waltham Forcing, 65; Trellis No. 22, 51; percentage basis this variation was from 19 to 65 percent. For the different varieties the percentage of set was: Waltham Forcing, 65; Trellis No. 22, 51; commercial Comet, 44; Stokesdale, 33; Valiant, 33; Marglobe, 41; Mass. A 13, 45. The most promising selections from the breeding work set fruit as follows: Selection 1, 36 percent; Selection 2, 36 percent; and Selection 3, 49 percent. The extreme importance of a good set of fruit on the first hand or cluster can be realized from the fact that the first fruit brought 24 cents per pound while later in the season the price went down to 4 cents.

Yield data from the selections indicate that none of the strains is superior in early yield to either Trellis No. 22 or Waltham Forcing. Selections 1 and 3 produced the greatest total yield. There was less cracking in all three selections than in Trellis No. 22 but more than in Waltham Forcing. Further testing of these selections is necessary to determine whether any are superior to those now being grown.

In the trials of new varieties grown without trellis, Red Cloud from Nebraska Agricultural Experiment Station was outstanding in the production of early fruit. It produced twice as many early No. 1 fruits as any other variety except Pennheart. Red Cloud produces fruit of size and shape more acceptable to the Boston market than Pennheart. Very few of the fruits crack or sunscald. Its disadvantages are poor color and lack of firmness compared with the trellis type tomato. Both Red Cloud and Pennheart are determinate varieties and cannot be grown on trellis. Of the trellising type tomatoes which were grown flat, Waltham Forcing produced the most early No. 1 fruits.

**Weed Control in Vegetable Crops.** (William H. Lachman.) The search for selective weed killers for vegetable crops has been continued. Sinox and Dow Selective Weed Killer belong to a group of chemicals known as dinitro compounds and these have been found valuable for killing weeds in peas, corn, and onions. In tests on the Experiment Station plots, these compounds were very effective in killing broad-leaved weeds but were of little value against grasses. More often than not they caused damage to the crops, depending upon the intricate combinations of weather conditions. On several occasions Sinox gave very good weed control in plantings of sweet corn with little crop damage, but in a number of other tests the corn leaves were scorched badly by the spray.

The new hormone weed killer, 2, 4-D, was also used in sweet corn but caused severe epinasty of the corn leaves. Almost all of the broad-leaved weeds were controlled satisfactorily, but the grassy weeds were unharmed.

A 2 percent solution of sulfuric acid killed many broad-leaved weeds in plantings of seedling onions but had little effect on grasses. The corrosive action of the acid on metal and clothing and its hazardous nature in general preclude the use of this method of weed control.

Frequently asparagus growers have difficulty eliminating weeds from their fields, particularly after the cutting season is over. A very potent weedicide, Dow Contact Weed Killer, was found to be especially good for this purpose. The spray should be directed down around the basal stalks of the asparagus plants for it kills the leaves or fern-like portion of the plant if these are wet by the spray.

The use of Stoddard Solvent as a weed killer in fields of carrots and parsnips was widely accepted by vegetable growers during 1945. Approximately 500 acres were treated in this manner and the growers were agreed that this was an ideal method of weed control since less labor was required, it was cheaper, and the job was done more quickly.

Stoddard Solvent is best applied when the weeds are small, since the weeds are more easily killed when young and the crop is benefited by early weed removal.



All annual weeds encountered, except ragweed, were killed by 100 gallons of the oil per acre. The carrots were relatively unharmed by the spray under most conditions, but the oil caused a scorching of the older leaves when the spraying was done while the leaves were wet.

The oil is highly volatile and does not leave any toxic residue in the soil. The oily flavor is dispersed from the carrot plant after a period of about fourteen days. Since the carrots and parsnips are not killed by this treatment they must be thinned as usual.

Young celery seedlings are not harmed by the oil, but half grown and older plants are considerably damaged. Most other crops including beets, cabbages, peppers, onions, asparagus, spinach, lettuce, turnips, and radishes are damaged or killed by Stoddard Solvent.

This oil can be used as a pre-emergence spray with susceptible crops; that is, the soil is sprayed just before the seedlings of the crop emerge from the soil. Crops of spinach, beets, and onions have been successfully weeded in this manner.

### **Breeding Sweet Corn, Peppers and Field Tomatoes for Massachusetts.** (William H. Larchman.)

*Sweet Corn.* The development of inbreds or parent strains of corn has been the major objective of this project until last year. A number of the inbreds have reached a remarkable degree of uniformity in most of their plant characteristics and now many of these have been cross-pollinated in various combinations to test their relative value as parents for the production of hybrid sweet corn. One of these strains has shown itself to be a good seed parent and has been named Mass. 32. A large western seed house has increased the supply of this seed to 1500 pounds and it is now ready for use as a parent in production fields.

Mass. 32 has been found to make an excellent hybrid when crossed with Connecticut 42. The hybrid is essentially an early Golden Cross Bantam and seems to be well adapted to Massachusetts conditions. It has an ear of good size and quality and matures about one week earlier than Golden Cross Bantam.

Several other experimental hybrids looked very promising in 1945, but further testing is necessary before their merits can be established.

*Peppers.* The object of this work has been to develop an early, high-yielding, thick-fleshed pepper of the California Wonder Type. A number of selections from commercial varieties and some hybrids among these have been grown in an effort to achieve this goal. This project has not yet progressed to the point where results are forthcoming.

*Tomatoes.* There is need for a large, early, smooth fruited tomato variety with high yielding ability. Selections from commercial varieties have been intercrossed and further selections from this material have been made for several years. A number of promising strains have been developed, but they have not reached the desired degree of uniformity or excellence and none have yet been released for trial among vegetable growers.

### **The Culture and Nutrition of Vegetables.** (William H. Lachman.)

1. Straw, sugar cane fiber, and horse manure were used as mulching materials for Rutgers tomatoes. The plants were grown unstaked and unpruned, and the treatments were replicated three times. These treatments were responsible for wide differences in yield in comparison with the control plots. The highest yield was harvested from the plots with the horse manure mulch; the lowest from those mulched with sugar cane fiber. The latter had a distinct depressing effect upon both vine growth and yield.

2. Carrot varieties and strains are planted each year to evaluate the various kinds, and these are generally tested for carotene during various stages of development and after they have been in cold storage for several months. It was plainly evident that the carrots were significantly lower in carotene in 1945 than they had been for a number of years. The only explanation that could be given was the great amount of cloudy weather and excessive rainfall during the growing season.

3. Tomato varieties with a determinate habit of growth, such as Pennheart, nearly always shed most of their leaves shortly after the ripening of the earliest fruit. The drain of food reserves from the leaves by the heavy set of fruit has been considered responsible for this condition. After various degrees of blossom removal, it was clearly evident that there was a negative correlation between the fruit load on the plant and retention of its foliage.

4. A peculiar chlorotic mottling of the leaves of greenhouse tomatoes has appeared for several years, very similar to the symptoms of magnesium deficiency; but large applications of magnesium as magnesium sulfate and high magnesium limestone failed to correct the condition. High potash supplies in the soil often aggravate magnesium deficiency in plants and the soil in question is well supplied with potash. Applications of potash are now being withheld from some of the plots in an attempt to determine whether an excess of potash is causing the trouble.

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## DEPARTMENT OF POMOLOGY

R. A. Van Meter in Charge

**The Influence of Various Clonal Rootstocks on Apple Varieties.<sup>1</sup>** (J. K. Shaw and W. D. Weeks.) For three successive years, spring frosts have interfered with a full crop in the large clonal rootstock orchard. As cold injury varied in severity with variety and in different parts of the orchard, it has invalidated yield records, but records of growth and bloom are still dependable. The trees are now growing vigorously. Results of an experiment like this come slowly, but the next few years should show interesting results.

An orchard of 256 trees of 16 varieties all on Malling IX was planted in 1943. There was some bloom and fruit last year and in 1946 nearly all varieties bloomed freely and set a fair to good crop in spite of spring frosts. The orchard is on higher ground than the orchard referred to above. There was little bloom on Northern Spy and Red Spy, but only four trees of the remaining 224 trees of 14 common varieties in the orchard failed to bloom. The trees have been in cultivation and are growing vigorously.

That Wealthy is very much dwarfed on Malling I while McIntosh on the same rootstock makes a typical semi-dwarf tree has been confirmed by further observations.

**Lethal Incompatibilities Between Clonal Stocks and Varieties of Apples.** (J. K. Shaw and W. D. Weeks.) Further studies of the lethal McIntosh strain R show that buds from the original tree of this strain failed to survive on the rootstock Spy 227. Evidently the lethal factor is present in the original tree. Failure resulted when both strain R and the non-lethal strain G were budded together on Spy 227. Evidently strain R is always lethal to Spy 227. Strain G was budded on a tree of strain R and buds from the resulting shoot were budded on

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<sup>1</sup>Two papers reporting on this project will appear in Vol. 47 of the Proceedings of the American Society for Horticultural Science.

Spy 227. At the same time buds from unbudded branches of the same tree of strain R were set in other Spy 227 rootstocks. At the present writing two trees of strain R have died in typical fashion, while all the trees of strain G are normal. This suggests that the lethal factor cannot pass into strain G and that strain G cannot communicate resistance to strain R; but the final conclusion cannot be reached until more time has passed.

Some trees of Starking grow very poorly on certain clonal rootstocks; they blossom very early in life and may die or, in some cases, seem to recover and grow better. Other trees of Starking grow normally on the same rootstock. Three-year-old trees budded from such weak and vigorous trees of Starking show the same difference. Those growing from weak trees are much less vigorous and some will probably die, while buds from the vigorous trees are growing normally. There seem to be two "strains" of Starking trees. Whether the trouble is a virus is not known.

**Tree Characters of Fruit Varieties.** (J. K. Shaw, A. P. French, O. C. Roberts, and W. D. Weeks.) The study of new varieties is a task without end. In the last report it was stated that Van Buren was the only bud sport that could be distinguished from its supposed parent variety, Duchess of Oldenberg. An examination of the original tree of Van Buren and propagation of buds from a normal branch and the sporting branch of this tree, and comparison with trees known to be Duchess of Oldenberg, has revealed that the original tree is not Duchess of Oldenberg but some other variety at present unknown. This single exception to our usual experience that red bud sports cannot be distinguished from the parent tree by nursery trees is thus removed and the general statement holds true. It is not correct to call Van Buren the Van Buren Red Duchess.

The inspection of nurseries for trueness-to-name was carried out in 1945 and is now in progress for 1946 on a somewhat enlarged scale.

A bulletin on the identification of blueberry varieties has been published.

**The Nature of Winter Hardiness in the Raspberry.** (J. S. Bailey, A. P. French, and R. A. Van Meter.) Canes of the six varieties, Marcy, Washington, Taylor, Milton, Latham, and Chief, were forced in the greenhouse at weekly intervals as in the fall of 1944. Again Chief and Latham were the slowest to start; Marcy and Washington started most readily; Milton and Taylor were intermediate. Milton behaved about as in 1944 but Taylor started much more readily. The rest period for all was over about a week later than in 1944.

Although the winter of 1945-46 was not severe, a large amount of cane killing occurred on all six varieties, undoubtedly caused by a very heavy infection of spur blight. Fermate sprays are being used to eliminate this source of trouble.

**Comparison of Cultivation and Sod Mulch in a Bearing Orchard.** (J. K. Shaw.) This project, which was started many years ago, has developed into a study of the mineral nutrition of apple trees, with special emphasis on magnesium deficiency and the value of orchard mulches. It is now planned to study the value of mineral leaf analysis in planning a fertilizer program for orchards. When unmistakable symptoms of a mineral deficiency appear, it is probable that much injury to the tree has already occurred. A knowledge of the mineral content of the leaf might suggest that certain elements were low and thus permit an earlier diagnosis of an approaching deficiency. The value of branch injections and leaf treatment as a means of diagnosis is also being studied.

The project has led to a gradually increasing appreciation of the value of potash and possibly phosphorus in the orchard; also to the belief that the so-called "complete" fertilizer is not complete. Magnesium, boron, and possibly calcium are as important as phosphorus and potassium to supplement the most



important element, nitrogen. No evidence of a deficiency of other than these six elements has yet been found in Massachusetts orchards. The value to the trees of some of these elements may be indirect in that they favor the growth of grass or cover crops and thus add humus and colloidal matter to the soil to benefit the trees.

A complete fertilizer and magnesium and boron may not be needed every year, as is nitrogen, but should be applied from time to time as orchard needs require. Magnesium limestone should always be used rather than a high calcium limestone when soil acidity drops below about pH 5.50. Boron in the form of borax should be applied to orchards that have shown deficiency, every 3 or 4 years at the rate of 30 to 50 pounds per acre. Boron in excess is toxic to plants, but apple and other tree fruits are not as sensitive to boron as are many other cultivated plants.

**Blueberry Culture.** (J. S. Bailey.) Mummy berry infection was reduced about 50 percent in 1945 by spraying four times with Fermate.<sup>1</sup> This work is being continued in 1946.

DDT and cryolite as dusts were applied to control the cranberry fruit worm. Since the infestation was very light, no significant differences were observed. However, it was determined that the fluorine on berries dusted June 13 with cryolite was well below the Federal tolerance.

Several new blueberry selections were added to the Experiment Station collection during the year.

The blueberry stunt, a virus disease, was found in Massachusetts in the summer of 1945. A careful survey was made of most of the larger plantings. In most cases where the disease was found the grower promptly removed all infected or suspicious bushes. This disease has probably been in Massachusetts for a number of years, but it does not appear to be spreading.

**Nutrition of the High-Bush Blueberry, Especially in Relation to Soil Reaction.** (J. S. Bailey.) After five years of manuring, there is still no evidence of any toxic effect of applications of manure as heavy as 20 tons per acre.

Several years' experience indicates that blueberries can be grown in a rather heavy sod provided plenty of nitrogen is applied and the plants are not in a situation where moisture becomes the limiting factor.

Much more chlorosis than usual appeared in some of the blueberry plantings in the early summer of 1946, following the application of ammonium nitrate in place of the usual sulfate of ammonia. This chlorosis is most noticeable on the varieties Sam and Pemberton.

**Control of the Peach Tree Borer.** (J. S. Bailey.) Paradichlorobenzene, ethylene dichloride, and propylene dichloride were applied again in the fall of 1945 at the standard dosages. Too few borers were present to make comparisons of effectiveness possible. Again there was no sign of injury resulting from any of the treatments. A very satisfactory emulsion of propylene dichloride in water was made by using oleic acid and triethanolamine.

**Magnesium Deficiency in Massachusetts Apple Orchards.** (J. K. Shaw and W. D. Weeks.) The typical leaf scorch characteristic of magnesium deficiency was rather uncommon in our orchards in 1945. Yet chemical analysis of the leaves showed a tendency for the magnesium content to be lower rather than higher. Trees which had been treated with dolomitic limestone held up better than others treated with Epsom salts. A possible explanation is that magnesium

<sup>1</sup>The results of this experiment will appear in Volume 47 of the Proceedings of the American Society for Horticultural Science.

may have been leached from the soil by the heavy rains of May and June, 1945, and that soil moisture continued ample through July and August so that little leaf scorch appeared. The problem of correcting magnesium deficiency is difficult, particularly with mature trees. We continue to recommend the use of magnesium sulfate in three or four sprays in early summer for immediate results and dolomitic limestone for more lasting effect. An enlarged program of study of this problem is under way.

**Thinning Apples with Sprays.** (J. K. Shaw.) In 1946 as in 1945, spring freezes interfered with attempts to thin apples by spraying in bloom, yet some results were obtained. Dowax, 1 gallon to 100, seemed to reduce set of Macoun but had little or no effect on five other varieties, including McIntosh. A commercial preparation of naphthalene acetic acid, 20 p.p.m., was more or less effective on several varieties and thinned certain crab varieties and Stark excessively. Applied at 30 p.p.m., it reduced the set of Wealthy about one third; not enough to eliminate some hand thinning. It caused considerable dwarfing and distortion of the leaves.

Two DN powders were used, both of which thinned several varieties quite effectively and caused much less leaf burning than did Elgetol used in 1944. There were generally not effective on McIntosh. It will not usually be necessary to thin McIntosh, but the unusually heavy bloom this year seemed to offer an opportunity to study this variety. It is evidently not easily influenced by blossom-thinning sprays. Naphthalene acetic acid was partially effective and caused little leaf distortion.

Because of the abnormally cold spring, it is not safe to draw many conclusions as to the value of blossom-thinning sprays. They are being used in commercial orchards and it seems probable that they will find increasing use as we learn more about them. Evidently the variety, stage of bloom, and possibly condition of the tree must be carefully considered.

Applications of naphthalene acetic acid and 2, 4-D at heavy concentrations in August to delay blossoming the following spring and thus escape frost damage seemed to have no certain effect. Applied at the time of fruit bud formation in May, it affected the leaves in the usual way and destroyed many fruit buds of Duchess but did not noticeably affect the buds of McIntosh and Wealthy. Neither material seemed to hasten the ripening and development of yellow color in Golden Delicious and McIntosh when the apples were dipped in various concentrations of the material in water.

**Chemical Control of Poison Ivy and Other Weeds.** (J. S. Bailey.) Several chemicals, including ammonium sulfamate and three formulations of 2, 4-D and some oils, were tried as herbicides for poison ivy, chokecherries, and American bamboo (*Polygonum Seiboldii* De Vriese). For poison ivy and chokecherry, ammonium sulfamate was superior to anything else tried. Nothing was effective on American bamboo. Ammonium sulfamate sprayed around young peach trees to eliminate grass and weeds killed the peach trees.

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## DEPARTMENT OF POULTRY HUSBANDRY

F. P. Jeffrey in Charge

**Broodiness in Poultry.** (F. A. Hays and Ruby Sanborn.) The chief objective has been to develop a line of Rhode Island Reds entirely free from the broody instinct. This goal has not yet been attained, largely because of the problem of deferred broodiness and the difficulties of adequate progeny testing of the breed-

ing males. A limited life span in birds also adds to the difficulties. Data indicate that females with broodiness deferred beyond the first laying year sometimes produce daughters that exhibit the broody instinct in their first year. Hens that only cluck without cessation of laying may transmit broodiness. The most recent data indicate that broody behavior often appears in the most intense winter layers.

The last complete generation was hatched in 1944 and completed their first-year record in 1945. Of the 66 pullets housed, 51 completed a full year. Only one exhibited the broody instinct, and that by a single period. These females are being tested for deferred broodiness.

**Effectiveness of Selective Breeding to Reduce Mortality.** (Regional Poultry Research Laboratory and Departments of Veterinary Science and Poultry Husbandry, Massachusetts Agricultural Experiment Station, cooperating.) Results of three generations of inbreeding to produce high and low mortality lines, with mortality rate the sole basis of selection, will not be completed until November 1946. The data indicate a significant difference between the two lines. One disturbing feature is that the mortality rate in the low line always exceeds the mortality rate in the control line. Complete results are not yet available.

**Genetic Laws Governing the Inheritance of High Fecundity in Domestic Fowl.** (F. A. Hays and Ruby Sanborn.) Particular attention has been given to methods of selecting breeders to raise the level of production. A seven-year study just completed (now in press) indicates that annual egg production is a very unsatisfactory criterion of the probable breeding value of hens in improved flocks.

Intensity of laying at all seasons of the year stands out as of highest importance in the station flock of Rhode Island Reds at the present time. Methods of measuring intensity and further evidence of its mode of inheritance are receiving special study.

At present, raising the average egg production of all daughters from the different families above 230 eggs averaging about 25 ounces to the dozen seems to depend upon higher intensity and greater freedom from winter pause.

**Fertility Cycles in Males.** (F. A. Hays.) Sex hormones have not proved effective in increasing natural fertility of old males in midwinter. The value of artificial light for this purpose will be studied further.

**A Genetic Analysis of Rhode Island Red Color.** (F. A. Hays.) This project has been concluded. General results indicate recessive genes controlling dark pigmentation.

**Secondary and Adult Sex Ratio in Relation to Hatchability.** (F. A. Hays.) Further data on sex ratio have been secured on high and low hatching lines. Sex has been recorded on dead embryos sufficiently advanced and upon all dead chicks up to sexual maturity. The two lines differ greatly in hatchability, and possible factors underlying this difference are being studied.

**Supplementary Nutritional Factors for Distillers' By-Products.** (F. P. Jeffrey, W. S. Ritchie, G. L. Woodside, and J. W. Kuzmeski.) The use of distillers' by-products in poultry breeding rations has received continued study, with special emphasis on the factor or factors in fish meal which have a supplementary value for hatchability. In a repeat trial, the use of 1.25 percent of fish meal as a supplement to the negative control gave disappointing results. The current trial shows that 2.50 percent red fish meal and 2.00 percent liver extract give equally good hatchability when supplementing the negative control.



**Breeding for High and Low Incidence of Internal Defects in Hen's Eggs.** (F. P. Jeffrey.) In the first generation, 769 Rhode Island Red pullets were produced from two separate lines of breeding. Breeders in line 1 were selected for freedom from blood and meat spots, blemished yolk, and fishy odor in their eggs. Breeders in line 2 were selected for a high incidence of these defects. Fertility and hatchability were excellent in both lines.

**Breeding White Plymouth Rocks for Eggs and Meat.** (F. P. Jeffrey.) Hatching eggs were secured from six prominent commercial breeders, and approximately 450 pullets will be housed this year. There was a wide variation among the strains, as shown by the following figures:

Hatchability of total eggs set.....	50 - 84 percent
Incidence of fast feathering.....	2 - 34 percent
Mortality to 8 weeks of age.....	2 - 16 percent
Pure white down.....	45 - 82 percent
Body weight at 8 weeks.....	1.00 - 1.47 pounds
(Average of both sexes)	

**Poultry Housing Investigations.** (W. C. Sanctuary and C. I. Gunness.) See report of Department of Engineering.

**Methods of Feeding.** (John H. Vondell.) This is the second year's study of methods of feeding layers. Three pens of 60 and 80 birds were hopper fed (free choice) laying mash, whole oats, and whole corn. Two pens were hopper fed laying mash and hand fed scratch feed to equal the amount of mash consumption. One pen was fed a complete all-mash. The test began September 28 and ran for twelve lunar months, with the following results:

	Hopper-fed	Hopper-fed and Hand-fed	All-Mash
Average egg production, percent.....	51.2	49.3	50.9
Mortality, percent .....	25.6	12.4	7.5
Feed consumption per bird, pounds.....	93.5	109.9	108.3
Feed cost per bird.....	\$3.09	\$3.68	\$3.79
Net return per bird over feed cost.....	\$3.39	\$2.53	\$2.62

## DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

**Poultry Disease Control Service.** (H. Van Roekel, K. L. Bullis, O. S. Flint, F. G. Sperling, M. K. Clarke, and O. M. Olesiuk.)

1. *Pullorum Disease Eradication.*<sup>1</sup> During the 1945-46 season, 1,259,623 samples, representing 630 chicken and turkey flocks, were tested. Compared with the previous season, 284,582 more samples and 101 more flocks were tested; but the average percentage of reactors was the same, 0.12. Progress in eradication of the disease is definitely evidenced by the fact that 95.3 percent of all birds tested are in 100 percent tested, non-reacting flocks. The average percentage of reactors was lower in flocks tested annually than in flocks tested for the first time or intermittently.

<sup>1</sup> A detailed report of the 1945-46 testing season has been published in Control Series Bulletin 128.

The testing results for turkeys are not so encouraging. A total of 21,473 birds, representing 103 flocks, was tested. Approximately 25 percent of the tested birds are in infected flocks. This situation may be improved through more persistent education regarding pullorum disease eradication and prevention.

During the past year natural pullorum infection was identified in pheasants for the first time in Massachusetts. The history of the flock showed that the infected birds were part of a group of pheasants imported from a Midwestern State by a Massachusetts State Game Farm. This observation suggests that pheasants may be a potential hazard to pullorum-free flocks.

2. *Diagnostic Service.* During the calendar year of 1945, 4224 specimens were received in 939 consignments, of which 509 were delivered in person. This is the largest number of consignments and specimens ever examined in a single year. The specimens were classified as follows: 3340 chickens; 715 turkeys; 75 ducks; 24 rabbits; 11 bovine semen; 9 each of canine feces, pheasants, and pigeons; 5 fish; 4 guinea pigs; 3 each of canaries, swabs from horses, and swine; 2 each of swine organs and bovine organs; and 1 each of bovine fetus, canine, deer, fox, goat feces, junco, rat, robin, and sheep.

Coccidiosis, tumors, pullorum disease, infectious bronchitis, and fowl paralysis were the conditions encountered most frequently. On the basis of gross examination, the tumors were classified as follows:

Lymphocytoma.....	31	Carcinoma.....	4	Fibroma.....	1
Myelocytoma.....	14	Embryonal nephroma.....	4	Hematoma.....	1
Leukosis.....	8	Leiomyoma.....	2	Melanoma.....	1
Hemangioma.....	6	Myxoma.....	2	Neurogenic sarcoma....	1
		Unidentified.....	2		

Avian tuberculosis was identified in three flocks. Fowl typhoid reappeared in serious proportions and 14 cases were called to the attention of the laboratory, 12 of which represented new known foci of infection and were located principally in two new areas. Fowl cholera was identified in 25 instances including 12 new premises. Fowl cholera was found also in turkeys, ducks, and a robin. The infection in the robin was believed to have originated from a flock of chickens on range where an acute outbreak of the disease was in progress. Newcastle disease was found in chickens in November, and 10 cases were identified before the end of the year. The recognition of this disease calls into question the diagnoses of infectious bronchitis made earlier in the year without the benefit of embryo inoculations.

An unusually large number of cases of poisoning in chickens was noted and confirmed by the Feed Control Service Laboratory when necessary. These included 1 arsenic; 9 coal tar, creosote oil, and derivatives; 4 salt; 1 cocoa bean; 1 kerosene; 1 naphthalene; and 2 phosphorus. Attempts to confirm the diagnosis of cocoa bean poisoning by feeding a small quantity of beans and shells to three birds were unsuccessful, but other observations indicated that the beans were the source of injury.

The 715 turkeys were received in 154 consignments and represent nearly twice the number of the previous year and ten times that of ten years ago. Pullorum disease, enterohepatitis, rickets, and paratyphoid were the diseases encountered most frequently. Coccidiosis, ulcerative enteritis, and perosis were each recognized in eight instances. Fowl typhoid was found in six poults and in one bird five months of age.

3. *Flock Mortality Studies.* Necropsies were made on 256 birds (111 females, 144 males, 1 unidentified) from the flock hatched in the spring of 1944 and maintained at the College for genetic studies. In the females, tumors, reproductive disorders, kidney disorders, and fowl paralysis accounted for more than three-fourths of the mortality. On the basis of gross examination, the tumors were classified as follows:

Lymphocytoma.....	11	Leukosis .....	2	Papilloma.....	1
Myelocytoma.....	4	Carcinoma.....	2	Unidentified.....	1
Leiomyoma.....	3	Hemangioma.....	2		

In males, cannibalism, bacterial and mycotic diseases, kidney disorders, and fowl paralysis were the conditions most frequently encountered, accounting for 60 percent of the deaths.

4. *Infectious Bronchiitis.* During 1945, 228 flocks were enrolled in the infectious bronchitis control program, which was carried on in much the same manner as in 1944. Several flocks enrolled in 1944 did not continue the program in 1945 for reasons not reported by the owners.

The bronchitis problem was greatly complicated by the identification of the Newcastle disease in Massachusetts in November 1945. Since the symptoms and lesions of the two diseases are so similar, an accurate diagnosis is not likely without resorting to refined and tedious laboratory tests. A survey is in progress to determine the distribution and incidence of these two diseases. Investigations into the transmission of the virus have recently shown that the virus of Newcastle disease can be isolated from fresh eggs laid by flocks which are in the terminal stages of the disease. The potential and practical significance of this finding is being investigated. When more personnel becomes available, methods of control will also be studied.

5. *Farm Department Brucellosis Control and Eradication.* The laboratory tested 388 bovine and 22 porcine blood samples by the standard tube agglutination method during the 1945 calendar year.

*Mastitis Testing Laboratory.* The progress in the development of an adequate mastitis testing laboratory has been consistent with delays experienced in all activities where new personnel and equipment are necessary.

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## WALTHAM FIELD STATION

Waltham, Massachusetts

Ray M. Koon, In Charge

The members of the research staff of the Waltham Field State are assigned to this branch by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Refer to reports of these Departments for results of investigations conducted at this Station.



## PUBLICATIONS

## Bulletins

- 428 Annual Report for the Fiscal Year Ending June 30, 1945. 71 pp. October 1945.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in field- or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

- 429 Annual Molt in Rhode Island Reds. By F. A. Hays and Ruby Sanborn. 24 pp. illus. December 1945.

The primary objective of this study was to determine the value of molting behavior as a guide in selecting breeding stock. Attention is given to both males and females in exhibition-bred and production-bred Rhode Island Reds.

- 430 Postwar Readjustments in Massachusetts Agriculture. By David Rozman. 35 pp. illus. March 1946.

Among the various postwar readjustments leading to greater efficiency and lower costs, primary consideration should be given to the reconstruction of farm units to take full advantage of land resources.

- 431 Identification of Blueberry Varieties by Plant Characters. By John S. Bailey and Arthur P. French. 20 pp. illus. May 1946.

This bulletin describes some of the vegetative characteristics which are useful in identifying plants of blueberry varieties in the nursery. Familiarity with these characteristics should aid in the prevention of variety mixtures.

- 432 Black Root Rot Resistant Strains of Havana Seed Tobacco for the Connecticut Valley. By C. V. Kightlinger. 20 pp. illus. May 1946.

This bulletin reports attempts to develop a strain of Havana Seed tobacco satisfactorily resistant to black root rot, yet capable of producing high yields of good quality.

- 433 Weather and Water in Cranberry Production. By Henry J. Franklin and Neil E. Stevens. 51 pp. illus. June 1946.

This is a supplement to Bulletin 402, and together they are intended to cover our present understanding of cranberry weather and water relations.

- 434 Mushrooms—For Food and Flavor. By William B. Esselen, Jr., and Carl R. Fellers. 20 pp. illus. June 1946.

Laboratory studies prove that mushrooms, besides serving as a flavor or garnish for other foods, are a nutritious food in themselves.

- 435 Vegetative Propagation of White Pine. By William L. Doran. 16 pp. illus. July 1946.

The difficulties experienced in propagating white pines from cuttings can be largely overcome. This is a description of methods used and results obtained.

## Control Bulletins

- 124 Twenty-fifth Annual Report of Pullorum Disease Eradication in Massachusetts. By the Poultry Disease Control Laboratory. 12 pp. July 1945.

- 125 Inspection of Commercial Feedstuffs. By Feed Control Service Staff. 32 pp. July 1945.

- 126 Inspection of Commercial Fertilizers and Agricultural Lime Products. By Fertilizer Control Service Staff. 28 pp. September 1945.

- 127 Seed Inspection. By F. A. McLaughlin. 40 pp. December 1945.

### Meteorological Bulletins

679-690, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By C. I. Gunness. 4 pp. each.

### Reports of Investigations in Journals

#### NUMBERED CONTRIBUTIONS

- 521 Composition and nutritive value of mushroom protein. By William H. Fitzpatrick, William B. Esselen, Jr., and Edith Weir. *Jour. Amer. Diet. Assoc.* 22 (4):318-323. 1946.
- 523 A note on the presence of pyruvic acid in Ebenezer onions. By Emmett Bennett. *Plant Physiol.* 20 (3):461-463. 1945.
- 538 Studies in the chemistry of grass silage. By J. G. Archibald. *Jour. Agr. Res.* 72 (8):277-287. 1946.
- 545 Influence of supplementary calcium and magnesium fertilizers upon nutritive value of kale. By Arthur D. Holmes, Leo V. Crowley and John W. Kuzmeski. *Food Res.* 10 (5):401-407. 1945.
- 548 The ascorbic acid, carotene, chlorophyll, riboflavin, and water content of summer squashes. By Arthur D. Holmes, Albert F. Spelman and Carleton P. Jones. *Food Res.* 10 (6):489-496. 1945.
- 550 Immunization against a lymphoid tumor of the chicken. I. Attenuation by freezing. By Carl Olson, Jr., *Cornell Vet.* 35 (3):221-230. 1945.
- 551 Immunization against a lymphoid tumor of the chicken. II. Use of centrifuged material. By Carl Olson, Jr. *Cornell Vet.* 35 (4):308-313. 1945.
- 552 Immunization against a lymphoid tumor of the chicken. III. Attenuation by heat, drying and chemicals. By Carl Olson, Jr. *Cornell Vet.* 36 (1):41-47. 1946.
- 556 Isolating gene E' for early sexual maturity. By F. A. Hays. *Amer. Nat.* 79:372-377. 1945.
- 558 Further data on correcting magnesium deficiency in apple orchards. By Lawrence Southwick and C. Tyson Smith. *Amer. Soc. Hort. Sci. Proc.* 46:6-12. 1945.
- 561 Frost injury to trees. By Malcolm A. McKenzie. *Trees* 6 (3):10. 1945.
- 562 Venting times for community cannery-type retorts. By William H. Fitzpatrick, John E. McConnell and William B. Esselen, Jr. *The Canner* 101 (1):16-18; 101 (2):12-13. 1945.
- 564 Some notes on the mechanics of applying selective herbicides to vegetable crops. By William H. Lachman. *Amer. Soc. Hort. Sci. Proc.* 46:323-328. 1945.
- 565 Ice cream as a source of riboflavin, carotene and ascorbic acid. By Arthur D. Holmes, John W. Kuzmeski, Carleton P. Jones and Frank T. Canavan. *New England Jour. Med.* 234:47-49. 1946.
- 566 Study of false presumptive tests from water treated with chlorine-ammonia. By James E. Fuller and Chas. K. Ewing. *New England Waterworks Assoc. Jour.* 59 (3):244-251. 1945.
- 568 Variation in bacteria, fat, ascorbic acid, and riboflavin content of commercial goat's milk. By Arthur D. Holmes, Harry G. Lindquist and Elliott K. Greenwood. *Jour. Dairy Sci.* 28 (11):853-858. 1945.
- 569 Some effects of thyroprotein on the composition of milk. By J. G. Archibald. *Jour. Dairy Sci.* 28 (12):941-947. 1945.
- 570 Utilization of Shrimp Waste. By Francis P. Griffiths. *Nat'l Chemurgic Digest*, August, 1945.

- 572 Propagation of the Briarcliff rose by cuttings. By William L. Doran. Florists' Exch. 105 (11): 17 and 21. 1945.
- 574 Vitamin content of field-frozen kale. By Arthur D. Holmes, Beula V. McKey, Katherine O. Esselen, Leo V. Crowley, and Carleton P. Jones. Amer. Jour. Dis. Children 70 :298-300. 1945.
- 575 Influence of incubation temperatures on differential tests of coliform bacteria. By James E. Fuller. Jour. Bact. 51 (4):457-464. 1946.
- 576 The vitamin content of mare's milk. By Arthur D. Holmes, Beula V. McKey, Anne W. Wertz, Harry G. Lindquist and Leonard R. Parkinson. Jour. Dairy Sci. 29 (3):163-171. 1946.
- 581 The control of the blueberry bud mite. By John S. Bailey and Arthur I. Bourne. Jour. Econ. Ent. 39 (1):89. 1946.
- 584 The application of chemistry to animal husbandry. By J. G. Archibald. Jour. Chem. Ed. 23:49-51. 1946.
- 587 The use of calcium salts in freezing McIntosh apples. By John J. Powers and William B. Esselen, Jr. Fruit Prod. Jour. and Amer. Food Mfr. 25 (7):200-202, 217. 1946.
- 591 Goat's milk as a source of bone building minerals for infant feeding. By Arthur D. Holmes, John W. Kuzmeski, Harry G. Lindquist and Henry B. Rodman. Amer. Jour. Dis. Children 71:647-653. 1946.

#### UNNUMBERED CONTRIBUTIONS

- Minerals for dairy goats. By J. G. Archibald and S. A. Asdell. Better Goat-keeping 1 (2). September 1945.
- The current feed situation. By J. G. Archibald. New England Homestead, January 12, 1946.
- Soil fertility and animal health. By J. G. Archibald. Amer. Fert. 104 (7). April 1946.
- Dutch elm disease in Massachusetts during 1945. By Malcolm A. McKenzie. New England Div. Amer. Phytopath. Soc. at New Haven, Conn., December 5, 1945. Abstracted for Phytopathology.
- Role of riboflavin in poultry nutrition. By Arthur D. Holmes. Northeastern Poultryman, December 1945, p. 37.
- Milk in the human dietary. By Arthur D. Holmes. Amer. Cookery, February 1946, p. 28.
- Tansy causes off-flavor. By H. G. Lindquist. New England Homestead 118 (17):12. September 8, 1945.
- Higher quality milk. By H. G. Lindquist. New England Goat News 8 (4):1, 3, 5-6; 8 (5): 3-4. April and May 1946.
- Milk products in bread enrichment. By J. H. Frandsen. Natl. Butter and Cheese Jour. 36 (10):66, 1945. Certified Milk 20 (234):7, 18, 1945; Hoard's Dairyman 90 (19):541, 1945; Amer. Milk Rev. 7 (9):336, 1945.
- Pests outside the four walls. By A. I. Bourne. Pests 13 (3):6-12. 1945.
- DDT saves colonial coach at Amherst. By A. I. Bourne. Pests 13 (4):31. 1945.
- Supply outlook for fungicides and insecticides in 1946. A. I. Bourne and O. C. Boyd. Fruit Notes, November 1945; Commercial Vegetable Grower, December 1945.
- Leaf-feeding sawfly larvae burrowing in structural wood. W. B. Becker and H. L. Sweetman. Jour. Econ. Ent. 39 (3):408. 1946.
- DDT, its uses in horticulture. By W. D. Whitcomb. Mass. Hort. Soc. Flower Show Program. March 1946. pp. 37-41.



## MIMEOGRAPHED CIRCULARS

FM 19 Returns from poultry farming in Massachusetts in 1944. By Charles R. Creek. 17 pp. October 1945.

High costs and high returns on 50 dairy farms in Massachusetts. By Charles R. Creek. 5 pp. June 1946.

Standards for Massachusetts dairy farms (4 pp.); Standards for Massachusetts poultry farms (2 pp.); Standards for Massachusetts market garden farms (4 pp.); Standards for Massachusetts fruit farms (3 pp.). By Charles R. Creek. Revised August 1945.

Dutch elm disease. By Malcolm A. McKenzie. Five progress reports.

Progress reports issued under the National Cooperative Project, Conservation of Nutritional Value of Foods:  
Effect of containers and other factors on the ascorbic acid content of processed tomato juice. By W. B. Esselen, Jr., and R. A. Woodward. 3 pp. 1945.

## Extension Publications

The following Extension Leaflets and Circulars were prepared wholly or in part by members of the Experiment Station staff:

Improving land the modern way. By Charles R. Creek and Joseph F. Hauck. Special Circular 122. 1945.

Cost figures on boulder removal. Farm Economic Facts, March 1946.

High costs—high returns. By C. R. Creek. Farm Economic Facts, June 1946.

Minerals for dairy cattle. By J. G. Archibald. Leaflet 236. 1945.

Winter injury to trees. By Malcolm A. McKenzie, Special Circular 117, revised.







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MASSACHUSETTS;

↑ AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 441

SEPTEMBER 1947

# Annual Report

For the Fiscal Year Ending June 30, 1947

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

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\*In charge

†At East Wareham

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# ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1946-47

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## DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

**Development of Statistical Data as Controls to Livestock Production Program.** (A. A. Brown and Elaine M. Roberson.) The 6 percent areal sample proved satisfactory for estimating the total number of farms. The estimate was within one half of one percent of the map count. Errors of estimate ranged from a low of 3.97 percent for number of farms to 19.47 percent for the number of chickens on commercial poultry farms. The estimates differed substantially from census data or crop reporting service data. The usefulness of the method to Massachusetts could be improved by type-of-farm maps, improved sample design, and improvements in field procedure.

It is not the intention, however, to carry the work any further. The Crop Reporting Service has recently begun to use the areal method for selected items; and, until the results of this experience become available, this project will be held in abeyance.

**The Effect of Public Regulation of Milk Marketing Upon the Organization of the Milksheds of Massachusetts Markets.** (A. A. Brown.) Attention was given during the past year to the movement of supplemental milk supplies from the North Central States to eastern markets, especially Boston. Data were assembled covering routes, rates, and service.

Normally milk cars are handled as head-end tonnage on scheduled passenger trains; the rule being to put them into the first available connection. During the fall months, in recent years of heavy shipment, several of the carriers have set up a "Milk-Extra" so as to better handle the traffic.

Through rates exist between many shipping points in Illinois, Iowa, Minnesota, and Wisconsin and principal eastern markets. Commodity tariffs applicable to milk and cream moving in Passenger Train Service are effective. Most of the rates are on a ten-gallon can basis. Only a few special gallon rates are published for movement in tank cars. When milk moves in tank cars between points having only the can rate, the amount to be charged is based on the rate per gallon of the ten-gallon can rate.

Among several selected shipping points in the dairy states, there was a range of 20 cents per can in the rate on a carload minimum of 2500 gallons (250 forty-quart cans). Madison, Wisconsin, had the lowest rate to Boston of \$1.39 per can, and Minneapolis the highest at \$1.59 per can; both rates before tax.

This short study will become part of a more inclusive one dealing with price and volumes as well as transportation of the supplemental supplies.

**A Study of Farm Real Estate Taxation, Methods of Taxation Reform, and the Effect of Such Measures on Farm Income.** (A. A. Brown and Judith E. Rosenthal.) Farmers would get a greater return on their curiosity if in addition to scrutinizing their property taxes they studied their valuations. The differences among farms in land, building, livestock, and machinery valuation are substantial. These differences may be interpreted as logically reflecting the assessors' applica-

tion of the principle of "fair market value" on the grounds that no two properties are ever identical; or contrariwise, that the differences are greater than actually exist for purposes of taxation. Valuation by owners, i.e., market value, is largely influenced by subjective considerations. This element, despite supervisory safeguards, affects assessors' valuations. Subjective consideration cannot be entirely removed even if we wished to do so. Nor is its complete elimination necessary for improvements in the valuation process. This can be achieved for land by applying a system of classification based on broad capability uses. The valuation of cattle would be more equitable if it were reduced to a salvage basis. The difficulties in properly evaluating breeds and grade and mixed herds would be partially overcome if beef values were applied; these values to be determined by the Commissioner of Corporations and Taxation and announced as of November for the succeeding valuation period.

**Improving Land on Massachusetts Farms.** (C. R. Creek.) The benefits and economic justification of land improvement activities have been appraised on a number of farms where additional land has been brought into production. Power machines such as bulldozers and gas shovels, plus heavy equipment such as brush-breaker plows and bog harrows, have been used to improve farm lands where hand tools and the usual farm machinery were inadequate. Land improvement work in most cases has been limited to a few acres of suitable types of soil on established farms, but in some cases whole farms have been developed on abandoned land. Woodland and brush have been cleared, shrubs and weeds plowed under or harrowed, boulders and stone walls removed from fields, and lowlands drained by dynamited ditches to increase the acreage in orchards, cropland, pasture, and poultry range on farms.

Land improvement work that formerly was costly in terms of man labor now requires only a few hours with power equipment. High income in recent years from land brought into production has paid for the use of machinery in addition to the saving of labor in improvement work. Speed and timeliness were most important where land was cleared for cash crops. Pasture and range improvement aided in lower costs on dairy and poultry farms. Net profits for one or two years often met the total costs of land improvement for certain crops. In extreme cases of high costs and low returns there was no economic justification for land reclamation.

The cost of land improvement work has been amortized for a five-year and a ten-year period to show the annual carrying charge (including interest); and the yields of pasture and crops that would be necessary to pay these annual costs have been calculated on the basis of prewar prices. Normal returns over costs of production would pay the land improvement charges for tobacco in one year, and for potatoes in one to three years for different types of reclamation work. For hay, a longer period was needed to repay costs that were generally lower per acre, because value of the product was less. Generally, five to ten years were required to pay the cost of land improvement. Normal values of pasture would meet improvement costs of \$75 to \$100 per acre in seven to twelve years. Physical limits on the total yields of crops or pasture and the margin of return over cost of production were determining factors for the cost of land improvement which could be justified on net returns. The indirect effect on the management of the farm by increased size of business and more efficient production was also important in the final decision on this type of work.

**Organization and Management of Poultry Farms.** (C. R. Creek.) Summaries of poultry accounts for six years showed that the one-third most profitable farms had higher net returns than the one-third least profitable group because of these factors in the farm business: (a) Larger size of business—1200 hens per farm

contrasted with 300 hens; (b) Diversification within the poultry business—more sales of hatching eggs and chicks instead of market eggs; (c) Higher egg production—one to four dozen more eggs per hen; (d) Lower cost of feed—two to six cents less per dozen; (e) More favorable feed-egg ratio—one dozen less eggs needed to pay for 100 pounds of feed; (f) More efficient labor—85 more productive work units per man; (g) Higher price received for eggs—one to seven cents more per dozen.

The type of poultry business was an important factor in obtaining high returns as illustrated by the market egg-hatching egg combination. These flocks were of larger size in order to supply a sufficient volume of hatching eggs, egg production was high because of superior breeding and extra care, average egg prices were high because of the premium for hatching eggs, feeding efficiency was high because of high egg production, and labor efficiency was high because these farms were large one-man units and labor-saving practices and equipment were used to advantage.

Many of the family-type poultry farms were started on a part-time basis with a small flock as a minor farm enterprise or while the operator was engaged in a non-farm occupation. Eggs and poultry were sold at retail prices to overcome the disadvantages of small size, low production, high feed costs, and low labor utilization. As experience was gained, the flock was expanded and the type of business developed through the market egg to the hatching egg-market egg combination for greatest profits and most efficient operation. Another adjustment in farm organization was the short-time change to broiler production in 1942 and 1943 in combination with market egg production. Many market egg farms that were operated efficiently showed average returns over a period of years, but were likely to show low returns if one or two measures of the farm business were unfavorable in any one year.

**More Efficient Labor Practices on Vegetable Farms.** (C. R. Creek.) Variations in organization of the packing crew and the use of a packing table accounted for a range of four to twelve man-minutes of labor per sack to unload, grade, and pack cabbage. Use of a conveyor belt made the packing operation easier with less mechanical damage to heads but about six man-minutes of labor were required per sack.

Various methods of harvesting and packing iceberg lettuce were observed to determine a combination of practices and equipment for efficient, labor-saving, and low-cost harvesting. Preliminary results indicate that bulk hauling of field-harvested heads which are trimmed and packed from a conveyor belt in the packing shed is preferable to field packing of market crates. More specialization and skill is possible with the packing shed system and lettuce can be graded to obtain more uniform packages. Other advantages are cleanliness, less fatigue, and less wilting of heads after packing.

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## DEPARTMENT OF AGRONOMY

Walter S. Eisenmenger in Charge

**Evaluation of Additions of Sodium Nitrate and Ammonium Sulfate when Applied to the Soil during the Late Summer Preceding the Spring when Tobacco Is Planted.** (Walter S. Eisenmenger and Karol J. Kucinski.) It is known that tobacco when planted after such crops as corn, clover, or timothy will not thrive well and will show mild or malignant symptoms of brown rootrot. These plants—corn, clover, and grasses—are comparatively high in lignin at maturity. Many other plants besides tobacco do not thrive well if lignin is present in large amounts.



It is believed that the physiology of plants during the early growing period is not normal under these conditions. The postulate has often been made that micro-organisms instrumental in decomposing tissues containing much lignin need an abundance of nitrogen and consequently rob the seed plant temporarily of this element.

Nitrogen at the rate of 0, 50, 100, 200, 300, and 500 pounds per acre in the form of nitrate of soda was applied to some hay plots in the early fall and to others in the spring before the plots were plowed. Tobacco was grown on these plots. An improvement in the crop index was found in nearly all cases; but the higher rates of 300 and 500 pounds of nitrogen did not greatly increase the yield of tobacco over the lower rates of 100 or 200 pounds. A greater effect due to the nitrogen was noted on those plots that were plowed in the early fall than on those which were similarly treated but plowed in the spring. The warm early fall days apparently gave the micro-organisms an opportunity to act more fully upon the fiber plowed under in the mature grass. Where lime was applied, the response was greater than where no lime was added. It may be concluded, therefore, that the limed land served as a better medium for the decomposing micro-organisms than the unlimed land.

In a similar experiment where corn was plowed under after the ears were removed and nitrate of soda was applied, there was an increase in the yield of tobacco of 100 to 200 pounds per acre.

On plots treated similarly in every respect except that sulfate of ammonia was the form of nitrogen applied, results were not so favorable as where nitrate of soda was applied.

**The Absorption of Chemical Elements by Plants.** (Walter S. Eisenmenger and Karol J. Kucinski.) In the field, copper ions at the rate of 225 parts per million, calcium carbonate at the rate of 5,000 pounds per acre, and magnesium sulfate at the rate of 225 parts of magnesium per million were added to soil in which rye, barley, and buckwheat were grown. There was no pronounced lowering of the magnesium in the plants where copper was applied. However, when copper and calcium were used together, in every case there was a pronounced increase of calcium intake in all three species of plants as compared with plants which grew where calcium and magnesium were applied singly or together; where copper was applied alone; where magnesium and copper were applied together; or where there was no treatment. There would seem to be no doubt that calcium and copper together augment the intake of calcium for these three species.

**Magnesium Requirements of Certain Plants.** (Walter S. Eisenmenger and Karol J. Kucinski.) Magnesium deficiency is conditioned by factors other than the amount available for plants. During dry growing seasons, magnesium deficiency is not nearly so evident as during wet periods. In the experimental field, one of the deficient areas has received lime every year and the other has not received either lime or magnesium. The symptoms of magnesium deficiency are invariably more pronounced on the plot receiving no lime than on the area where lime was applied. On the magnesium-deficient areas, the pH is about 4.4 where no lime has been applied and about 6.9 where lime has been applied.

In the orchards, it has been found that applications of magnesium are often of no great aid in correcting magnesium deficiency. In the magnesium plots it has been well demonstrated by chemical analysis that very frequently no increase in magnesium or only very small increases occur in the plant tissue of perennials grown on land where magnesium has been applied. This is unlike the usual behavior of annuals.

Plants frequently found as weeds in the garden, such as grasses, members of the aster family, isolated cases of members of the Boraginaceae and Convolvu-

laceae families, and other well-developed plants, grow seemingly as well on the magnesium-deficient soil as they do on plots supplied with magnesium. On the other hand, such weeds as purslane (*Portulaca oleracea*) and the chickweeds grow abundantly where magnesium has been applied but their presence on land not receiving magnesium is negligible.

**Magnesium Deficiency.** (Walter S. Eisenmenger and Dale A. Hinkle.) It has been noted that chlorosis of the older leaves and lack of normal growth are symptoms of magnesium deficiency in plants. An attempt is being made to determine the relative fate of chlorophyll, carotene, and xanthophyll in the process of tissue deterioration as well as to determine the comparative supplies of magnesium in the more common agricultural soils in Massachusetts. The latter involves the base exchange capacity, the magnesium involved in the base exchange, and the total magnesium.

It has also been a part of the project to determine whether or not mass action of large quantities of magnesium when applied to apple orchards would influence magnesium intake as compared with normal applications, which in the past have proved futile. Results to date have not been encouraging. It was found that most of the apple leaves had the same magnesium content although the applications of this ion to the soil areas around different trees varied greatly in amount. This indicates that old apple trees may be adjusted physiologically to the intake of a somewhat definite amount of the magnesium ion so that mass action would be unlikely to have much effect on magnesium intake.

The relative yields of common vegetable crops are being observed to determine the economic significance of magnesium applications.

**Sunflowers and Their Possibilities.** (Karol J. Kucinski and Walter S. Eisenmenger.) The Canadian varieties of sunflower, which have considerably shorter stalk and smaller head than the Russian Mammoth, are being tested. This shorter variety will withstand breakage of the stalks due to windstorms, and this merits consideration. At the Experiment Station, acre yields for the Canadian type sunflower ranged from 2,000 to 2,400 pounds; the Russian sunflower averaged 2,525 pounds per acre; and a black hulled sunflower of medium height, which has been selected at the Station, produced an average of approximately 2,800 pounds per acre.

**Long Time Fertility Tests.** (Karol J. Kucinski and Walter S. Eisenmenger.) About sixty years ago a series of test plots was established to study the effects on the soil of a long-time fertilizer program. For the last three years, hay has been grown on these plots. As in the two previous years, yields of hay indicate that in the case of plots treated singly with either nitrogen, potash or phosphorus, the nitrogen plots showed the greatest response. Liming alone produced approximately twice as much hay as no treatment. The greatest response to lime occurred on plots treated with both potassium and phosphorus. On the unlimed plots, the heaviest yield was obtained where a complete fertilizer was used.

**Soil Conservation Research Projects.** (Karol J. Kucinski and Walter S. Eisenmenger.)

*Use of Snow Fencing in Controlling Wind Erosion.* The heavy cover of snow during the winter of 1946-47 prevented any drastic dust storms. For several years, snow fencing has been satisfactorily anchored when held with iron pipes  $4\frac{1}{2}$  to 5 feet long, driven 18 inches into the ground and spaced about a rod apart. It has been found that where one snow fence is placed only at the head of a "blow-out" area, perpendicular to the prevailing winds, a deposition of soil occurs when the wind blows from the opposite direction. It is suggested there-

fore, that in large "blow-out" areas, parallel fences be placed perpendicular to the prevailing wind, one at each end of the "blow-out."

**Farm Fish Ponds.** Considerable interest has been shown by farmers who are adopting soil conservation practices in building fish ponds on their farms. In the South and West, farm fish ponds are common and successful. In New England this is a new venture and studies are being made to determine the kinds of fish and rate and type of fertilization that should be recommended for the various types of farm ponds constructed. Very little is known about the yield and rate of growth of self-propagating fish in this vicinity. Information of this nature is greatly desired, especially in regard to species of trout.

**Investigation of Beach Grass.** The American or native beach grass (*Ammophila breviligulata*) found commonly on Cape Cod has been used with various degrees of success in the stabilization of beach areas and coastal sand dunes. Recently machinery has been developed for the rapid transplanting of beach grass plants, and this has made it of economic importance to obtain transplants in sufficient quantity. Studies are in progress to determine what response beach grass will make to fertilization, in the natural state and when propagated; and to find feasible methods of encouraging the growth and increasing the rate of propagation of natural stands in order that they may eventually be used commercially as transplants.

**Black Root Rot of Tobacco.** (C. V. Kightlinger.) The purpose of this project is to improve Havana Seed tobacco by breeding new strains that will produce tobacco leaf of better type and quality in more profitable amounts than existing strains of Havana Seed. Special emphasis is being placed on breeding new strains that are highly resistant to black root rot and capable of producing tobacco of acceptable type and quality in profitable amounts on black root-rot infested land.

Havana 211, Havana K1, Havana K2, and Havana K2-24 seem to be the best of the new strains produced so far. They yield well under most black root-rot conditions, as well as under more favorable growing conditions, and are acceptable to most growers for yielding capacity. However, owing to their larger size, these strains require greater care than many farmers are accustomed to use in preparing tobacco for harvesting and in harvesting and curing it; consequently they are sometimes not fully acceptable to the tobacco trade for quality. Better preparation for harvesting, more careful harvesting, and better curing of tobacco, regardless of whether it be the new strains or common Havana Seed, would produce tobacco of better type and quality and often of greater weight, thus resulting in more profit to both the tobacco trade and the producer, especially the latter.

Some differences exist among these new strains. Havana 211 will usually outyield the others under similar growing conditions, especially under favorable conditions. Havana K1 and K2 usually outyield Havana K2-24, especially under favorable growing conditions. Havana K2 and Havana K2-24, usually sort out in approximately the same percentage of weights per grade as does well-grown and well-cured common Havana Seed; while Havana 211 and Havana K1 usually sort out a higher percentage weight of light wrappers and seconds grades. One part of the tobacco trade seems to prefer Havana K2 and Havana K2-24 because they produce tobacco that resembles common Havana Seed so closely in type and quality. The other part of the trade seems to prefer Havana 211 and Havana K1 because they produce the greater amounts of so-called light tobacco. Further trials are needed to ascertain just how acceptable these strains may become with the tobacco trade and which of the strains may gain general preference. Better curing practices on the part of many farmers who grow these new strains may change present tendencies for preference of strains on the part of the trade.



The most desirable plants within the existing strains are being selected and propagated to improve habits of growth in general and type and quality in particular. Still other strains are being produced by crossing plants that embody the desirable properties of the different strains in highest degree.

**Potato Seed Treatments.** (C. V. Kightlinger and H. M. Yegian.) Seven varieties of potatoes (Green Mountain, Irish Cobbler, Russet Rural, Katahdin, Chippewa, Sebago, and Earlane) and eight seed treatments were used to ascertain the comparative tolerance of common varieties of potatoes to the treatments and also their effectiveness in controlling rhizoctoniosis and scab. The materials used were corrosive sublimate, corrosive sublimate plus acid, cold formaldehyde plus acid, Semesan Bel, Sanoseed, Spergon, Fermate, and Thiosan, all prepared and used according to recommendations. The potatoes were dormant or only slightly sprouted at the time of treatment.

The inorganic materials caused little if any noticeable injury to tubers or reduction in stands of Green Mountain, Irish Cobbler, and Russet Rural; slight injury to tubers and moderate reduction in stands of Katahdin, Sebago, and Earlane; moderate injury to tubers and heavy reduction in stand of Chippewa. The organic materials caused no noticeable injury to tubers of any variety and no reduction in stands of Green Mountain, Irish Cobbler, and Russet Rural; little reduction in stands of Katahdin, Sebago, and Earlane; and moderate reduction in stand of Chippewa. Injury to tubers consisted not only of injury to eyes and sprouts but also of pitting of the tubers. The treated and untreated potatoes of each variety were taken from the same lot; therefore, it seems reasonable to conclude that the reductions in stand were caused by the treatments and not by rhizoctoniosis on the sprouts before they emerged from the ground.

None of the seed treatments seemed to increase the vigor of the plants. On the contrary, there seemed to be some retardation in the emergence of plants from the treated seed of some of the varieties. There were no consistent differences in the amounts of infection of rhizoctoniosis, either on the growing plants when about a foot tall or on the tubers grown from treated and untreated seed. Although these experiments yielded no specific information on the effectiveness of disinfecting treatments to prevent injury by *Rhizoctonia* to the young sprouts before they emerge from the ground; nevertheless, on the basis of the results obtained, it seems reasonable to conclude that the use of disinfecting seed treatments is of doubtful value in preventing the development of rhizoctoniosis on the stems and tubers of potatoes.

Little or no scab developed on any of the potatoes at any time in these experiments, so they yielded no information regarding the effectiveness of these disinfecting seed treatments for controlling scab. However, owing to the widespread occurrence of the scab-causing organism (like the rhizoctoniosis-causing organism) in most cultivated land, and the fact that the scab disease develops late in the growth of potatoes, the use of disinfecting seed treatments would seem to be of doubtful value for controlling scab. Satisfactory control of both rhizoctoniosis and scab of potatoes must be sought by other means than the use of disinfecting seed treatments.

**Fertilizer Placement for Potatoes.** (C. V. Kightlinger and H. M. Yegian.) Green Mountain potatoes were grown on one-twentieth acre plots, replicated four times. Approximately one ton per acre of 5-8-7 fertilizer was applied in four different ways: all banded, two-thirds banded and one-third broadcast, one-third banded and two-thirds broadcast, and all broadcast. The broadcast fertilizer was applied and harrowed into the soil before the potatoes were planted. The potatoes were planted on May 20; sprayed with Bordeaux mixture at weekly

intervals throughout the season, beginning June 26, and with DDT and nicotine sulfate as needed; and harvested October 19 and 21.

There was no striking difference in the yields of potatoes of any class or size obtained from the different ways of using fertilizer this season.

**Potato Variety Trials.** (Karol J. Kucinski, Ralph W. Donaldson, Walter S. Eisenmenger.) The 1946 season was considered an exceptionally good potato year. The yields obtained in the variety tests ranged from 474 bushels per acre for Sequoia to 190 bushels per acre for USDA 46952. Based on yields of marketable size, the potato varieties in the Experiment Station plots ranked as follows: Sequoia, Green Mountain, Pontiac, Mohawk, Chippewa, Teton, Houma, Sebago, Irish Cobbler, Warba, USDA 627-103, Katahdin, and USDA 46952. The Houma variety produced 347 bushels per acre, but approximately 23 percent of these were "B" size or smaller.

**Pasture Renovation Experiments.** (Wm. G. Colby.) Work with pasture renovation was begun in 1943 in cooperation with the U. S. Department of Agriculture Regional Pasture Laboratory at State College, Pennsylvania. The nature and scope of the project was given in last year's report (Mass. Agr. Exp. Sta. Bul. 436: 13-14, 1946.)

**Herbage Yields.** Yield data from all of the different trials thus far conducted, indicate that untreated sods yielded from practically nothing for very poor sods up to one ton of dry matter per acre for the better ones. Good Kentucky bluegrass and natural white clover sods liberally topdressed with lime and a complete fertilizer produced up to two tons of dry matter per acre, while areas which had been tilled and re-seeded in addition to being limed and fertilized, yielded three tons of dry matter and in several cases three and one-half tons. The reseeded areas, in addition to giving greater total yields, maintained more uniform production throughout the grazing season. A mixture of Ladino clover, red clover, and alsike was used on all areas. Smooth brome grass (*Bromus inermis*) was the grass most frequently used, with smaller plots of orchard grass (Finnish late hay strain), timothy, and meadow fescue also included for comparative purposes. Although it is sometimes difficult to secure good stands of brome grass, this grass seems to show the most promise.

**Land Drainage.** Some of the best potential pasture land in the State is now practically useless because of poor drainage. Therefore, the first step in any renovation program is to provide adequate drainage. Many such areas can be satisfactorily and economically drained by dynamiting; others may require the use of a dry land dredge of some sort.

**Reclaiming Newly Drained Land.** The surface of newly drained land is usually so rough and uneven that considerable difficulty may be experienced in seedbed preparation even with the aid of a heavy brush and bog harrow. Observations were made on the use of a large machine using the "roto-tiller" principle for tilling rough, recently drained areas. In one operation this machine not only leveled off but broke up and cut to pieces the many tough fibrous tussocks or hummocks which were present. Where the land is not stony this machine shows real promise.

**Time of Seeding.** Comment was made last year that late summer seeding had been more satisfactory than spring seedings. It was pointed out that weather conditions were usually more favorable for summer than for spring seedings and that this was probably the most satisfactory explanation. It now appears that weather is not the only factor involved. In several instances where the land had been long out of cultivation, difficulty was experienced in establishing a new

seeding when the seeding operation followed immediately after tilling, liming, and fertilizing. If seeding was delayed for several weeks, little difficulty was experienced. Apparently, therefore, the late summer seedings were more successful, not only because weather conditions were more favorable, but also because a period of time had elapsed between tilling, liming and fertilizing, and seeding. In bringing under cultivation land which has long been idle, farmers are advised to apply lime and fertilizing materials some weeks ahead of seeding or planting.

**Red Clover Variety Trials.** (Wm. G. Colby.) This project, carried on in co-operation with the U. S. Department of Agriculture Bureau of Plant Industry, is concerned with the resistance of some of the newer strains of red clover to certain diseases. Northern anthracnose (caused by *Kabatiella caulivora*), a disease which is becoming increasingly serious in other sections of the country, was prevalent on some of the more susceptible varieties included in this year's test. The variety Midland, for example, was seriously damaged. It remains to be seen whether or not this disease will become a serious hazard to red clover in Massachusetts. It may be that weather conditions this year were peculiarly favorable for its development.

**Trials with Sorghum and Sudan Grass Strains.** (Wm. G. Colby.) Notwithstanding the superior performance of a well-established, well-managed Ladino clover-brome grass pasture during July and August, the need for additional grazing is frequently felt, particularly during dry, hot seasons. One of the best crops available for providing supplementary grazing at this time is sudan grass or possibly sweet sorghum. Both produce heavy crops of palatable nutritious feed. If a reasonable amount of care is exercised in seedbed preparation, fertilizing, and seeding, crop failures are rare. Thus far, however, dairymen have been cautious about growing either of these species largely because of the possible danger of hydrocyanic acid poisoning.

Last season several strains of sudan grass and one of sweet sorghum were grown. In addition to obtaining yield data, tests were made of the cyanide content of the herbage at two growth stages. The Rancher strain of sweet sorghum was obtained from South Dakota where it was bred for low hydrocyanic acid content.

Samples were first taken for hydrocyanic acid determination on July 22 when most strains were in full head. All plots were then cut, the hay removed and an application of ammonium nitrate made to supply elemental nitrogen at the rate of 65 pounds to the acre.

Samples for a second test were taken on September 12. All chemical determinations were made by Professor Emmett Bennett of the Department of Chemistry.

Although Rancher Sorghum and Tift sudan grass ran considerably higher in hydrocyanic acid content at the first cutting than commercial sudan or sweet sudan, a cow would have had to consume from 50 to 60 pounds of green material at one time of either of these strains before there would have been any danger of poisoning. She would have had to consume 300 pounds of sweet sudan grass before being poisoned.

All strains ran much higher in hydrocyanic acid at the second cutting, with only small differences between strains. A cow would have had to consume from 20 to 25 pounds of green material of the second cutting at one time before danger of poisoning. Heavy fertilization with a nitrogen fertilizer was no doubt an important factor in the production of the relatively high content of hydrocyanic acid of the second cutting.

It would appear from these results that all of the four strains tested could be grown for midsummer pasture in Massachusetts without serious hazard of causing hydrocyanic poisoning.



### Corn Improvement Program. (Hrant M. Yegian.)

*Uniform Double Cross Tests.* Twenty-five commercial hybrids of the U. S.-13 maturity group were tested, with five northeastern experiment stations cooperating. An experimental hybrid, (B164 x WF9) x (40B x L317), gave the highest yield—134.3 bushels of shelled corn per acre, calculated at 15.5 percent moisture, and 21.1 tons of silage per acre, calculated at 70 percent moisture. Ohio 3143, Pioneer 300, Funk G-94, Iowa 4059, and Conn. 830 were also high producers. The hybrids which performed well at this station were also consistently high in yield in the other four tests.

None of the predicted double crosses in the early maturity group produced as much grain as the Mass. 62. New experimental double crosses are being tested this year in an effort to find one which will outyield Mass. 62.

*Single Cross Test.* A set of 45 single crosses involving all possible combinations of ten selected inbred lines in the early maturity group and another set of 45 single crosses in the midseason maturity group were tested cooperatively. On the basis of these tests a few of the promising predicted double crosses are being made for testing during the 1948 season.

Last year a new set of 45 early maturing single crosses was made here. They are being tested for their general adaptability in the Northeastern region.

*Date and Rate of Planting.* The results of further yield tests with four hybrids ranging in maturity from early to late, planted on three different dates (May 10, 20, and 30) and at three rates (3, 4, and 5 plants per hill), were again not very reliable. Excessive rainfall in the spring and poor drainage of the field caused wide discrepancies among the replicates. Although early planting hastened maturity from 7 to 10 days, it was very difficult to prepare a deep mellow seed-bed, control the weeds, and secure a good stand, because of cold and wet soil conditions which favored poor germination and seed rot.

*Onion Breeding.* (Hrant M. Yegian.) *Hybrid Onions.* In 1946 a number of bulbs of male-sterile lines supplied by Dr. H. A. Jones of the U. S. Department of Agriculture were pollinated with selected strains of our Ebenezer lines to determine their relative combining ability. The resulting hybrid seeds from these crosses are being used for set production and will be distributed to interested local farmers for experimental testing.

*Pre-harvest Spraying.* Further tests for the control of storage rot of onions by spraying with Fermate, Puratized N5E, Isothan Q-15, Wettable No. 604, Wettable Spergon, and Dithane D-14 did not give any control of rot in storage. The various fungicidal chemicals were applied three times at weekly intervals before the onions were pulled.

In most instances infection of the bulbs takes place through wounds at the neck of the topped onions or through damaged roots, which may account for the ineffectiveness of the fungicides to control storage rot. Immature onions, big fleshy bulbs, or thicknecked bulbs are especially susceptible to infections. The most practical method known for reducing loss is to store only sound, properly cured onions in cold storage under controlled conditions at 32°–35° F. and low humidity.

*Fertilizer Application.* It is a generally accepted practice in the Valley to apply from 2000 to 2500 pounds per acre of a complete commercial fertilizer such as 5-8-7 to onion fields. Although the fertilizer is broadcast and disked in to a depth of 3 to 4 inches about a week prior to planting the sets, there have been cases, nevertheless, where serious fertilizer injuries have occurred on light sandy soils

under adverse weather conditions. Furthermore, most of the growers have found it necessary to make an additional application of 500 to 700 pounds of a complete fertilizer during late May to replace excessive leaching losses by spring rains and to supply readily available plant food to the crop during a time when it is making a steady and rapid growth.

The results of last year's trial indicate that more efficient use of commercial fertilizer could be made by split application, consisting of 1000 pounds per acre of 5-8-7, broadcast and disked in prior to planting; 500 to 700 pounds per acre about the middle of May; and 500 pounds more about the first part of June. This would insure a steady supply of abundant plant food with a minimum loss through leaching and should entail no extra labor inasmuch as there are available fertilizer distributors which can be attached to powered onion cultivators.

## DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

**A Study of the Mineral Elements of Cows' Milk.** (J. G. Archibald.) The work with cobalt has been completed, at least insofar as the present development of the project is concerned; and the results have been published in the *Journal of Dairy Science* Vol. 30, No. 5, May 1947. The following is quoted from the article:

Cobaltous acetate was fed as a supplement (500 mg. daily) to the rations of eight cows for a period of two months by the double reversal method and the milk was analyzed for cobalt. The results revealed that feeding the supplement consistently raised the amount of cobalt in the milk. The average increase was four-fold. The milk from cows receiving the supplement averaged 2.4 micrograms of cobalt per liter in contrast with 0.6 micrograms per liter when the cows were on the control ration.

The obvious possible significance of these results lies in their application to calf nutrition. In our experience, young stock have showed greater susceptibility to the nutritional anemia which is characteristic of cobalt deficiency than older cattle have. In the light of these results, it would seem that in areas where cobalt deficiency is common, the requirements of calves for this element might most naturally and logically be supplied through the milk of cows whose rations have been fortified with supplemental cobalt.

Interest in this work has been shown recently on the part of the industrial processors of milk. One firm states that in connection with their "use of milk products as fermentation media, . . . very small concentrations of the so-called trace elements are of great importance." Cobalt is stressed by them as one of the principal elements in this connection.

The element nickel will be investigated during the winter of 1947-48.

**A Study of Quality in Roughage: Composition, Palatability, and Nutritive Value of Hays as Affected by Curing, Harvesting, and Storing Procedures.** (J. G. Archibald, M. L. Blaisdell, and H. N. Stapleton.) Preliminary studies with the 1945 and 1946 hay crop indicate marked differences in the composition of different lots of hay, especially with respect to their content of protein, sugar, and carotene. These differences are thought to be due to such variables as weather during the growing period and at curing time, kind of crop, and methods of harvesting and storing. Their significance with regard to palatability and nutritive value of the hay produced is, in our present state of knowledge, pretty largely a matter of conjecture. Existing knowledge on the subject is fragmentary, inconclusive, and even contradictory. It is the aim of this project to obtain authentic information. Work has just been begun and results are not as yet available.

## DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

**Septic Tank Studies.** (James E. Fuller.) This is a continuation of work previously reported (Mass. Expt. Sta. Bul. 436, p. 17, 1946). This study was concerned with the penetration of sewage-type coliform bacteria into the soil of disposal fields receiving sewage effluents from three septic tanks which represented three retention periods for raw sewage: 8, 12, and 24 hours. The soil samples were examined to determine their coliform indices by the conventional procedure of gas production in lactose broth, as outlined in the Standard Methods of Water Analysis (American Public Health Assn.). Organisms isolated from positive fermentation tests were studied to determine their relationship to sewage-type coliform bacteria (*Escherichia coli*). Results showed almost no sewage-type organisms in the soil, in spite of the fact that the flow from the 8-hour retention tank was so rapid that soil surrounding the disposal line was frequently saturated with moisture. Organisms isolated were, for the most part, the same as those isolated from soil (of the same type) that did not receive septic-tank effluent. Two conclusions resulted from the study: (1) the length of retention of sewage in the tanks did not influence the results obtained from the soil, and (2) the sewage-type coliform bacteria isolated from the raw effluent either did not penetrate into the soil or did not survive. Further study is planned to investigate the survival of sewage-type coliform bacteria in soil under different conditions.

**Bactericidal Properties of Surface-active Agents.** (James E. Fuller.) It was reported previously (Mass. Expt. Sta. Bul. 436, p. 17, 1946) that preliminary tests had been made on 42 surface-active agents to determine their germicidal efficiency. Several of these agents, representing three chemical groups, were chosen for further study of their germicidal properties, in different concentrations, against two representative types of bacteria, *Escherichia coli* and *Staphylococcus aureus*. The chemical groups represented were quaternary ammonium compounds, phosphonium compounds, and aliphatic sulphonates. Usually a certain concentration is recommended for the use of an agent. Results of the experiments indicated that the effectiveness of the agents varied for the different bacterial species, and that a formula could be derived for each agent showing the relationship of concentration of the agent and dosage time for any given bacterial species. The results of the experiments indicated that the agents could be made more widely useful if directions for their application were made more flexible, and economy of materials might result if weaker concentrations were employed where speed of disinfecting action is not important or necessary.

**Microbiological Fixation of Copper in Soil.** (Charles Hurwitz.) This study was undertaken to determine the effect of the soil microorganisms on the availability of the soil supply of copper to higher plants. Copper leached from the soil by neutral, normal ammonium acetate is considered available. Leachable copper was found to be greatly increased by an unknown soluble component of oat straw and alfalfa meal when either sodium chloride or ammonium acetate was used as the leaching solution, the effect being found in both Merrimac sandy loam and Dunkirk silty clay loam. This unknown soluble component is decomposed by soil microorganisms in about 14 days at 29° C., 37° C., and 45° C., no marked differences being observed at any of these temperatures. At 2° C., no decomposition of the soluble component occurred in 21 days, but when this soil was placed at 29° C., decomposition proceeded as before. Work is in progress now to characterize this unknown soluble component and to determine its agricultural significance.



Laboratory Service, July 1, 1946 to October, 1946. (James E. Fuller.)

Water samples, bacteriological tests..... 22

This service was discontinued in October, 1946.

## DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

Diseases of Trees in Massachusetts. (M. A. McKenzie and A. Vincent Osmun.)

*The Dutch Elm Disease Problem.* In 1941 the Dutch elm disease, caused by the fungus *Ceratostomella ulmi* (Schwarz) Buisman, was discovered in Massachusetts. One diseased tree was found in Alford, Berkshire County, just over the line from New York State. As of July 8, 1947, the disease has been isolated from 502 trees of 52 municipalities in 8 counties of Massachusetts. The spread of the disease from year to year is shown by the following table:

Year	Cumulative Totals		
	Trees	Towns	Counties
1941.....	1	1	1
1942.....	7	5	2
1943.....	11	6	2
1944.....	43	15	2
1945.....	85	24	3
1946.....	381	47	8
1947 (July 8).....	502	52	8

Until 1946, occurrence of the disease in Massachusetts was limited to the Connecticut Valley and the area between this boundary and the New York State line. Currently, however, affected trees were discovered in Quincy and more recently in nearby towns in Norfolk County as well as in Plymouth and Bristol Counties. Since the principal known vector of the causal fungus is a bark beetle, *Scolytus multistriatus*, which has been known to be present in eastern Massachusetts from about 1900, the diseased trees in that section of the State may be regarded as more than individual isolated cases such as sometimes occur independently of the major area of disease and beetle vector infestation. On the basis of experience, increase in the number of diseased trees locally parallels closely the build-up of beetle population if the causal fungus is present.

An important part of the work is now, and must continue to be, the exploration of possible further spread of the disease in Massachusetts, as well as obtaining additional data in areas where trees are known to be affected. Detailed reports are furnished to the Massachusetts Department of Agriculture, to local officials, and to private citizens involved, regarding findings in individual municipalities, with special reference to need for action in retarding the spread of the disease.

Experiments are in progress in cooperation with the Department of Entomology on the use of spray materials for the control of carrier beetles.

The investigation of disease resistance deserves further attention. Thus far, however, other commitments have precluded studies to determine evidence of possible resistance to disease in elms of Massachusetts.

*Other Tree Problems.* Fifty-three diseases of twenty-nine species of trees, including eight diseases of elm, were identified from approximately 450 specimens and inquiries received during the year. The *Cephalosporium* wilt of elm was

reported from two additional municipalities in the State. *Verticillium* sp. was isolated from several species of woody plants.

Anthracnose of maples and oaks, black spot of elms, and other leaf diseases caused by fungi are prevalent on trees currently. In some instances premature defoliation is traceable to this type of fungus infection.

A needle blight of Colorado fir (*Abies concolor*) was found on specimens collected at Newburyport, Mass. This disease is caused by the fungus *Rehmiellopsis balsameae*. Under suitable conditions the resultant disease may become epiphytotic in plantations. Accordingly, the growth of the current season may be rather uniformly scorched in appearance, resembling damage by late frosts to which cause this fungus disease was formerly often attributed. Although the disease was first known in Massachusetts on Colorado fir, later the causal fungus was found on balsam fir (*Abies balsamea*) in Maine. It seems assured that the fungus is native in eastern United States on balsam fir and may have spread to ornamental plantings of Colorado fir introduced into the vicinity. The disease has not been found in the Western States, native range of the Colorado fir.

Neglect of general maintenance work on street trees is increasingly important as a cause of tree injury. The rising cost of this work to municipalities is the primary factor involved. The result of the accumulation of weakened parts of trees may be seen widely in the State following ordinary storms. Inevitable accidents involving such trees may serve to direct needed action toward necessary, constructive tree improvement and protection programs.

**Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment.** (W. L. Doran.) Work on the vegetative propagation of the Kudzu vine was continued and a paper on the subject prepared for publication. Best results with this species were obtained when cuttings, each made to consist of one node, its leaf and a young axillary branch, were taken in mid-July, given a powder-dip treatment with indolebutyric acid, and set in sand-peat. The rooted cuttings were wintered in the greenhouse and, in cooperation with the Department of Agronomy, set in the field in spring for later observations as to hardiness and growth.

Work on the vegetative propagation of hemlock and of white pine was continued and a bulletin written and published about the latter.<sup>1</sup>

Different clones of hemlock, like different clones of white pine, were found to respond very differently to treatments with the same root-inducing substance, the best rooting being from more than 80 percent with some clones to less than 10 percent with other clones. Indolebutyric acid 150 to 200 mg./l., 20 to 18 hr., often improved the rooting of cuttings of hemlock taken in early winter; but the rooting of cuttings taken in October was more improved by naphthaleneacetic acid 50 mg./l., 18 hr.

Continued attention was given to the use of fungicides in combination with root-inducing substances for the treatment of cuttings, and it was found that a given fungicide when added to Hormodin No. 3, in the proportion of 15 percent fungicide, does not have the same effect on cuttings of all species. Fungicides which improved the rooting of summer cuttings when thus used were zinc ethylene bisdithiocarbamate (HE178E), ferric dimethyldithiocarbamate (Fermate), and zinc mercaptobenzothiazole with (leaf-bud) cuttings of a *Rhododendron catawbiense* hybrid; diphenyl guanidine phthalate (Gauntal) with cuttings of *Viburnum Carlesii*; Fermate with flame azalea; 2, 3-dichlor-1, 4-naphthoquinone (Phygon) with *Cotoneaster adpressa*, and HE178E with red cedar. Phygon was also safe with *Viburnum Burkwoodii*.

<sup>1</sup>Doran, W. L. Vegetative propagation of white pine. Mass. Agr. Expt. Sta. Bul. 435, 16 pp. • illus. July 1946.

Tetramethyl thiuram disulfide (Tuads), zinc trichlorophenate (Dow Seed Protectant No. 9) and Guantal were apparently injurious to the leaf-bud cuttings of Rhododendron, and Dow Seed Protectant No. 9 had a similar unfavorable effect on cuttings of red cedar and Japan quince.

The effects of solution-immersion treatment applied in the usual manner with only the bases of the cuttings being immersed, were compared with the effects of immersion of the entire cuttings in solutions of a root-inducing substance. Rooting of fall cuttings of two yews was more hastened or improved by complete immersion in indolebutyric acid 150 mg./l. or naphthaleneacetic acid 25 mg./l., 18 hr. than by basal treatment only and this was true also of fall cuttings of Hinoki cypress in indolebutyric acid 50 mg./l., 18 hr. But the rooting of fall cuttings of arbor-vitae and two species of Juniper was as much improved by one method as by the other, and the rooting of cuttings of five hemlocks taken between October and January was more improved by immersing only the bases of the cuttings than by immersing the cuttings entirely.

Some work was done with potassium nitrate in solution, used with or without a root-inducing substance. Rooting of December cuttings of Norway spruce was improved by potassium nitrate 100 mg./l., 23 hr., used alone. Rooting of fall cuttings of red cedar, oriental bitter-sweet, and inkberry was more improved by potassium nitrate 50 mg./l. used with indolebutyric acid than by the latter used alone.

Powder-dip treatment of December cuttings of Norway spruce with 2, 4, 5-trichlorophenoxyacetic acid 0.5 mg./gm. resulted in improved rooting if the carrier was activated charcoal but not if it was talc.

Arasan (tetramethyl thiuram disulfide), used as a seed treatment, protected seedlings of *Pinus Mugo* var. *Mughus* against damping-off better than did either Phygon or Spergon (tetrachloro-parabenzquinone) similarly used.

Applied as a soil treatment immediately before seeding, Arasan 0.5 gm. per square foot improved the stands of Carolina Rhododendron and a *Rhododendron catawbiense* hybrid.

**Diseases of Plants Caused by Soil-infesting Organisms, with Particular Attention to Control Measures.** (W. L. Doran.) The application of soil fungicides in fertilizer used as a carrier was found to be a simple and effective method for the control of certain soil-borne fungus diseases of plants. It is especially useful in the case of such light applications (per acre) that the fungicide could hardly be distributed except in some carrier. A liquid carrier would mean more labor and, as is stated below, the results with water may be inferior to those with fertilizer.

Especial attention was given to the control of clubroot of cabbage, smut of onion, and damping-off of certain vegetables by some organic fungicides applied to the soil in a 5-8-7 fertilizer (15.6 gm. per square foot) immediately before seeding. The effectiveness and safety of some of the fungicides thus applied were compared with their effectiveness and safety when applied in water to soil immediately after seeding. Observations were meanwhile made as to which soil fungicide applied in fertilizer is better and safer with one species of plant, which with another.

Dithane D14 (disodium ethylene bisdithiocarbamate), Dow Seed Protectant No. 9 (zinc salt of 2, 4-trichlorophenol), Fermate (ferric dimethyldithiocarbamate), Arasan or Tuads (tetramethyl thiuram disulfide) gave better and safer control of damping-off of all vegetables when applied in fertilizer to soil before seeding rather than in water after seeding.

Phygon (2, 3-dichloro-1, 4 naphthoquinone), Tuads, and Dithane applied in fertilizer gave better control of damping-off in limed soils than in the same soils not limed. But there were also good results with these and other fungicides applied in fertilizer to unlimed soils.



The fungicide, in fertilizer, which gave the best results with one kind of vegetable did not necessarily, however, give the best results with all others. Damping-off of cabbage, onion, pepper, tomato, beet, and cucumber was well and safely prevented by Tuads 0.5 gm. (Rates of application are expressed in grams per square foot in all cases.) Dithane D14, 2.5 cc., gave good results with all of these except cucumber. Dow Seed Protectant No. 9, 0.45 to 0.75 gm., gave good results with beet, cabbage, and cucumber but not with onion, pepper, or tomato; Phygon only with pepper and tomato.

Fermate and Tuads applied to soil in fertilizer immediately before seeding gave better control of onion smut than when applied in water to soil immediately after seeding. Best control of onion smut was by Dithane D14, 3.0 cc.; Phygon 0.6 gm.; or Tuads, 0.55 or 0.65 gm. With 53 percent smut in an untreated soil, there was no smut in this soil when Phygon 0.65 gm. or Tuads 0.65 gm. had been applied in the fertilizer.

Tuads 0.55 gm. or 0.65 gm. thus applied gave good control of cabbage clubroot in seedbeds and these treatments were followed by improved growth of plants.<sup>1</sup>

Fungicidal treatments of the seeds of *Lilium regale* were continued, tetramethyl thiuram disulfide giving the best results, and a paper was written.<sup>2</sup>

It was found that, lacking all fungicides, fair control of damping-off is possible by merely delaying the first watering for a few days after seeding, and the abstract of a paper read on the subject was published.<sup>3</sup>

**Tomato Leaf Mold Caused by the Fungus *Cladosporium fulvum* Cke.** (E. F. Guba, Waltham.) Tomato types developed for resistance to *Cladosporium fulvum* Cke. have been generally accepted by the greenhouse forcing industry. The most satisfactory type has been designated Improved Bay State. The resistance of Improved Bay State to tomato leaf mold was derived from a "pimpinellifolium" wild type from Ecuador designated U.S.D.A. Plant Introduction No. 112,215. The utility and resistance of Improved Bay State to *Cladosporium* leaf mold has been substantiated by other station workers. Confirmation of this fact by B. S. Crandall, Office of Foreign Agricultural Relations, U.S.D.A., working at Estacion Experimental Agricola de Tingo Maria, Peru, South America, is especially significant.

Similar resistance was bred into Marglobe but the finished type lacks firm fruits and a high yielding habit. The hybrid of *L. esculentum* var. Prince Borghese X *L. peruvianum* outcrossed to Pan America, and submitted by W. S. Porte of the U.S.D.A. as No. 44B292, is being pure-lined for resistance to leaf mold and further study.

Supervision of seed production of Improved Bay State is planned, to preserve the desirable characters of the tomato for the industry. Seed samples have been distributed to interested workers in many countries.

This study, in progress since 1925, and since 1933 concerned with breeding for resistance to the disease, is nearing completion.

**Causes and Control of Decay of Squash in Storage.** (E. F. Guba, Waltham.) Study was made of the effect of field applications of fungicides on disease control and yield of Butternut squash. The plots were 16 x 210 feet in dimension. They were sprayed five times from August 5 to September 10.

The diseases involved were powdery and downy mildews (*Erysiphe cichoracearum* DC and *Pseudoperonospora cubensis* (B & C) Rost.) respectively, and black rot (*Mycosphaerella citrullina* (Smith) Gross.).

<sup>1</sup> The writer read a paper on "Fungicides applied in fertilizer for the control of cabbage clubroot and damping-off" at the Annual Meeting of the Northeastern Division of the American Phytopathological Society on November 26, 1946. An abstract will appear in *Phytopathology*.

<sup>2</sup> Doran, W. L. The protection of lilies against damping-off. *National Horticultural Magazine* 25:4:385-386. 1946.

<sup>3</sup> Doran, W. L. Control of damping-off by a delay in first watering after seeding. *Phytopathology* 36:8:679. August 1946.

Comparisons were made of Fermate  $1\frac{1}{2}$ , Phygon 1, Zerlate 2, pounds in water, 100 gallons, Bordeaux 4-4-100, tribasic copper sulfate 4, and no treatment. The percentage of infected fruits in the unsprayed plots at harvest was 18.5 percent and 22.7 percent of the total. The percentage of infected fruits in the sprayed plots varied from 3.5 to 9.1 percent. The best control was obtained with Phygon.

The plots sprayed with Phygon and with copper showed the least foliage disease. The total yield and the average weight of the squash fruits were the least in the Phygon-sprayed plots.

Like numbers of squash from the sprayed plots were dipped in fungicide and combined fungicide and wax emulsions at harvest and then stored until mid-January. The least loss from black rot occurred in lots of squash from the Phygon-sprayed plots immersed in Phygon or in combined Phygon and wax emulsion, and from the Zerlate-sprayed plots immersed in Zerlate or Formalin solution. Control of rot in storage was not significant when the squash fruits from the sprayed plots were not immersed before storage. The least shrinkage from evaporation of moisture occurred among the lots of squash immersed at harvest in combined fungicide and wax emulsion.

**Interrelation of Wettable Sulfur, Lead Arsenate and Lime in Apple Spraying.** (E. F. Guba, Waltham.) Except for drought conditions from June 25 to July 24, the growing season was marked by continuous rains which contributed to the worst scab epidemic on record. Severe frosts caused a great reduction in the set of fruit of some varieties. Premature defoliation and discoloration of McIntosh trees from scab was prevalent.

Scab was controlled best on Delicious with Phygon and Puratized in a throughout schedule of six applications, and with a schedule of three sprays of Flotation Sulfur Paste alternating with three sprays of Puratized. Fermate gave significant control, and lime added to Flotation Sulfur Paste and lead arsenate controlled scab as well as the same mixture without lime. On McIntosh the best scab control was obtained with Phygon, Puratized, and Fermate, and significant control with Flotation Sulfur Paste and Puratized alternating. Eradication of foliage scab was best accomplished with Puratized. The action of liquid lime sulfur on the fungus was less satisfactory. Phygon and Fermate exert a marked fungistatic or inactivating action on the scab spores in foliage infections. Wettable sulfurs are not fungistatic in this respect. Fermate and wettable sulfur combined offer advantages over either fungicide alone in the control of scab.

The least amount of russeted Delicious fruit was associated with Phygon and Fermate, each combined with lead arsenate, and with wettable sulfur alone and with lead arsenate alone. Frost russetting was prevalent on Baldwin fruit among all treatments; russet ranged from 25 percent with Phygon to 70 percent with Puratized, indicating a significant influence of the spray chemical on the incidence of injury. The Phygon-sprayed trees showed abnormally colored foliage and depreciated weight of the harvested fruit.

Analysis of the sulfur residue before and after applications of sulfur indicates that the addition of lime increases the loss of sulfur from weathering. Paste sulfurs or the finest particle sulfurs weather off less than coarse sulfur.

**Tobacco Frenching Induced by High Soil Temperature.** (L. H. Jones and M. A. Tio.) Two varieties of tobacco—Havana Seed, a cigar tobacco, and Yellow Mammoth, a cigarette tobacco—were grown in a compost soil at two soil temperatures, a high of 95° F. and a low of 70° F. Frenching symptoms in the most extreme forms appeared on both varieties at the high soil temperature in 8 days. In 21 days terminal growth stopped, and rosetting or polyphyllly was the main characteristic symptom. No frenching symptoms developed at the low soil temperature.

Parallel with the soil cultures was a series of solution cultures, at the same temperatures and with the same varieties of tobacco. The solution, Shive's  $R_5S_2$  at 1.75 atm., consisted of  $KH_2PO_4$ ,  $Ca(NO_3)_2$ ,  $MgSO_4$ , with  $FeSO_4$  as a source of iron. Frenching did not appear at either the high or the low solution temperature. The failure to induce frenching at the high solution temperature precludes the suggestion that root metabolism at a high temperature could be a cause of frenching. The nutrient solution was altered in several ways and various forms of iron were used in an effort to induce frenching, all with negative results. Soil extracts were obtained from frenching soils by mixing soil with distilled water and filtering. These were added to nutrient solutions but caused no symptoms of frenching.

Frenching has always been obtainable with a compost soil. To test a field soil, two tobacco field soils taken in the autumn were used for culture media parallel to the compost soil. At 95° F. the compost soil produced frenching in 14 days; field soil No. 1 in 20 days; and field soil No. 2 in 58 days in one plant of four. The field soils had been stored until February and were quite dry. Subsequent tests showed that air-drying of soil eliminated the ability to cause frenching. Autoclaving the soil for one hour at 15 pounds steam pressure also prevented frenching.

Tests made on frenched leaves showed a large amount of nitrates when it was known that there was an ample supply of nitrogen in the soil. Tests for major and minor elements, made by the floating disc method, showed a response to iron. Leaf analyses of frenched leaves showed a low amount of iron compared with normal leaves. It appears that a lack of iron in the plant seriously interfered with a proper utilization of nitrates. The osmotic concentration of the cell sap of leaf tissue of frenched leaves was above normal; 14 atmospheres for frenched leaves and 9 atmospheres for normal leaves. A histological examination of leaf tissue showed a lack of palisade tissue and spongy parenchyma in the frenched leaves.

Experiments in which iron was mixed with the soil in the forms of  $FeSO_4$  mixed with peat and  $FePO_4$  mixed with peat resulted in the complete prevention of frenching with the  $FeSO_4$ -peat mixture. Results were not so good with the  $FePO_4$ -peat mixture, and practically no control was obtained when either of these chemicals and peat were used separately.

When a little soil that had caused frenching was mixed with an autoclaved soil frenching was induced at 95° F. but not at 70° F. No frenching occurred in an uninoculated autoclaved soil.

The evidence now at hand indicates that at a soil temperature of 95° F. there is an effect on the soil flora which causes oxidation of iron to an unavailable form, and this oxidation takes place more rapidly than the reducing reactions which would normally maintain some iron in a ferrous form available for intake by the plants. Frenching results from a deficiency of available iron and may be prevented by supplying an excess of iron in the form of a ferrous humate made by mixing  $FeSO_4$  with peat.

**Resistance to *Fusarium dianthi* Prill. et Del., the Cause of a Serious Carnation Wilt Disease.** (E. F. Guba, Waltham.) The following varieties of carnations have been crossed and self pollinated in the long effort to develop desirable commercial types resistant to *Fusarium Branch Rot*:

Dorothy Napier	Helen Hussey	Millers Yellow
Puritan	John Briry	Woburn
Maine Sunshine	Elizabeth Rowe	Paragon
My Love	Georgina	Hazel Draper
Eleanor	King Cardinal	Tom Knipe



These varieties were selected for selfing and crossing because of their inherent resistance to *Fusarium dianthi*. A large number of seedlings are being studied for their reaction to the disease and other characters. Two additional wilt diseases, Verticillium wilt (*Verticillium cinerescens* Wr.) and bacterial wilt (*Phytophthora caryophylli* Burkh.), have been found in eastern Massachusetts.

**Toxic Effect of Wood Preservatives on Plants.** (L. H. Jones.) Pentachlorophenol as a wood preservative is frequently used with range oil as a diluent. It may be easily and rapidly applied to lumber with a paint brush. When such treated lumber was covered with soil, no injury to plants was observed, even when their roots were in contact with the wood. However, when such treated lumber is used above ground, grave injury to seedlings may result from volatilization of the oil by high light intensity and high temperature coupled with poor ventilation. The injury is in the nature of a scorching due to the dissolving action of the oil on the epidermis. The injury is most severe where the treated sides of flats are higher than emerging seedlings. If the plants can grow higher than this source of the volatile substances, they are not affected by the gases.

Veneer wood plant bands strongly impregnated with range oil caused grave injury to plants when no ventilation was provided.

#### Miscellaneous Studies. (E. F. Guba, Waltham.)

*Control of Seed Decay and Damping-off of Vegetable Seedlings by Seed-borne Chemicals.* Studies have been continued to provide the vegetable growing industry with the latest information on the subject. During the year, zinc oxide, Semesan, Phygon, cuprous oxide, Arasan, Fermate, and Spergon were tested in comparison with no treatment. No one material was satisfactory with all vegetables; but for all the vegetables tested, one or more materials gave good results.

*Celery Dermatitis.* Many celery growers are poisoned from handling celery, especially by contact with spoiled celery caused by *Erwinia carotovora* (Jones) Comm. s.a.b. The relationship of other spoilage organisms is being investigated. A clinic was conducted by Dr. Francis M. Rackemann of Boston and his staff, in cooperation with the plant pathologist, which was attended by several celery growers. Studies are in progress in cooperation with Dr. Rackemann to learn the answers to various aspects of the problem.

*Resistance to Potato Late Blight.* Potato seedlings resistant to late blight, originated by Dr. F. J. Stevenson of the U. S. Department of Agriculture, were compared with standard susceptible varieties. Mohawk and Green Mountain vines were completely destroyed before September 1. The vine growth of all seedlings remained free of late blight up to October 2, when the tubers were dug. Seedlings B 69-16, B 70-5, and B 61-3 showed a trace of late blight tuber rot, and tuber infection was severe with seedling B 76-43. Seedling B 69-16 performed the best of the entire lot in every respect.

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## DEPARTMENT OF CHEMISTRY

Walter S. Ritchie in Charge

**Factors Affecting the Vitamin Content of Milk and Milk Products.** (Arthur D. Holmes.) During the past year three studies conducted under this project have been completed. All the products studied were produced locally, the ice cream and mare's milk being produced at the University. The various samples of goat's milk were obtained from prominent goat dairies located at widely scattered points in the State.

*Goat's Milk as a Source of Bone-Building Materials for Infant Feeding.* (Arthur D. Holmes, John W. Kuzmeski, Harry G. Lindquist, and Henry B. Rodman.) In previous studies of goat's milk attention was given to the vitamin content of commercial winter goat's milk and to the variation which occurred in the fat, ascorbic acid, and riboflavin content of individual samples of milk. Inasmuch as goat's milk is frequently used as an infant's food, it is obviously desirable to have data concerning its reliability as a source of the minerals required for the satisfactory development of an infant's skeleton. Twenty-four samples of fresh, raw goat's milk were collected at various localities in Massachusetts and southern New Hampshire. The milk was produced by four breeds of goats most common in this area; French Alpine, Nubian, Saanen, and Toggenburg. The samples were shipped to the laboratory packed in ice, and were about 24 hours old upon arrival. Average values obtained by analysis were calcium 137 mg. per 100 gm.; magnesium 17 mg.; potassium 170 mg.; phosphorus 112 mg.; fat 4.4 percent; and protein 3.4 percent. These data show that average goat's milk is a rich source of minerals and is therefore a valuable product for infant feeding. However, a final appraisal of its true value as a source of bone-building materials for infant feeding must await data regarding the extent to which infants can utilize the minerals supplied by goat's milk.

*Stability of Vitamins in Stored Ice Cream.* (Arthur D. Holmes, John W. Kuzmeski, and Frank T. Canavan). Ice cream has become an important component of the human dietary, about 3 gallons being consumed per capita per year. This volume of ice cream contains significant amounts of proteins, fats, carbohydrates, minerals, and vitamins. Since the proteins in ice cream are of animal origin, they have superior biological value. Only a relatively small amount of commercial ice cream is consumed at the time of its manufacture, and a question naturally arose regarding the stability of the vitamin content of ice cream during storage. Accordingly several samples of ice cream manufactured on a commercial scale in the dairy laboratory by the formula included in last year's Annual Report were stored at  $-10^{\circ}$  F. for seven months. Determination of the riboflavin, carotene, and ascorbic acid content of samples of ice cream before and after storage showed a 5.4 percent loss of riboflavin and a 15.7 percent loss of carotene during storage. These data indicate that the riboflavin and carotene in ice cream stored at  $-10^{\circ}$  F. for seven months are fully as stable as these vitamins present in a variety of canned vegetables stored for a corresponding period of time. Thirty samples of freshly made ice cream were assayed for reduced ascorbic acid, and none was detected. It is assumed that the ascorbic acid in the fresh, whole, raw milk was rapidly oxidized by the occluded air which constituted about half the volume of the ice cream.

*Enhancing the Riboflavin Content of Mare's Milk.* (Arthur D. Holmes.) Cow's milk is generally recognized as one of the best natural sources of riboflavin. On the other hand, as noted in last year's Annual Report, milk produced by mares that grazed in the same pastures and consumed hay grown in the same or adjacent fields as that provided for the cows, contained only about one-tenth as much riboflavin as the cow's milk. This raised the question of the comparative riboflavin content of the two types of milk and whether it would be possible to significantly increase the riboflavin content of mare's milk by feeding crystalline riboflavin as a supplement to the normal ration. Finely pulverized riboflavin crystals were diluted with a large amount of sugar pulverized to the same fineness. The homogeneous mixture was placed in No. 2 hard gelatin capsules, which are smaller than a kernel of corn but larger than an oat kernel. These were mixed with the crushed oats and readily eaten by the mares—all horses are particularly fond of sugar. A total of 5.26 gm. of riboflavin was administered to each mare

during a 22-day feeding period. The riboflavin content of the milk was significantly increased, but the increase was of short duration and the riboflavin content soon returned to pre-experimental levels. While it is possible to materially increase the riboflavin content of mare's milk, it is evidently more efficient to administer riboflavin to the foal directly rather than through the mare's milk.

**A Study of the Changes in Vitamin Content Coincident with Different Stages and Rates of Maturity of Vegetables Used for Home Consumption.** (Arthur D. Holmes and Carleton P. Jones.) Two studies were completed during the fiscal year. Both produced data concerning the vitamin content of vegetables—winter squash and winter tomatoes—produced locally.

*Composition of Squashes after Winter Storage.* (Arthur D. Holmes and Albert F. Spelman.) Squashes have been an important article of diet in this locality since early colonial times. In this study four varieties, Blue Hubbard, Butternut, Golden Cushaw, and Delicious, were secured about the middle of February from chain and independent grocery stores, private homes, and the University dining hall storage house. This represented a wide variety of storage conditions which were believed to be similar to those in general use for squashes consumed in this locality. The four varieties of squashes contained about the same amount of riboflavin. The Butternut squash had higher calcium, iron, magnesium and phosphorus content than the other varieties. The squashes contained less calcium, iron, and magnesium but considerably more riboflavin and phosphorus than was found in lettuce and kale grown on the University farm. The values for carotene, riboflavin, calcium, iron, magnesium, and phosphorus varied with the different varieties and with individual squashes within the varieties; but the results show that all four varieties, after four-month's winter storage, were good sources of food ingredients essential for the human diet. The most striking values obtained were for carotene in Butternut and Golden Cushaw squashes, for they were unusually rich in this essential food constituent.

*Food Value of Hormone-Treated Tomatoes.* (Arthur D. Holmes, Albert F. Spelman, John W. Kuzmeski, and William H. Lachman.) According to agricultural statistics, the commercial crop of tomatoes in 1944 was 4,051,000 pounds, which is equivalent to over 31 pounds for each man, woman, and child in this country. During recent years numerous investigators have studied the effect of spraying tomato blossoms with various plant hormones to increase the number of fruits and to produce seedless tomatoes. It is generally believed that tomato seeds have very little human food value. Accordingly, a question arose concerning the relative food value of normal and seedless tomatoes. In the present study, tomato seeds of the Waltham Forcing variety were planted December 1, and the seedlings transplanted to the greenhouse February 1. Fertilizer was applied at the rate of 20 tons of horse manure and one ton of commercial 5-8-7 fertilizer per acre. A solution of 0.075 gm. of beta-naphthoxyacetic acid per liter was sprayed directly into the center of fully opened tomato blossoms with a small atomizer until droplets of the solution could be observed inside the flower. During the interval between planting the seeds and harvesting the tomatoes, the greenhouse was exposed to 1000 hours of bright sunshine. Very little difference was found in the water content or the magnesium content of the hormone-treated and control tomatoes. The hormone-treated tomatoes averaged slightly more nitrogen, phosphorus, potassium, and calcium; but the controls contained an average of 18.2 mg. of ascorbic acid per 100 grams as compared with 14.4 mg. for the hormone-treated.



**The Investigation of Agricultural Waste Products. 1. The Chemical Investigation of Lignin.** (Emmett Bennett.) Continued attempts have been made to increase the nitrogen content of lignin. Oxidations with nitric acid were not particularly fruitful and have been discontinued. Attempts also have been made to unite urea and lignin. With the means at our disposal, the reaction was not successful.

The most promising procedure tried was the ammonification and simultaneous oxidation of lignin in a medium of concentrated ammonium hydroxide and oxygen at atmospheric pressure. This reaction was improved by previously subjecting the lignin to a mild hydrolysis with citric acid. Chlorinated lignin ammoniated in the above manner yielded the highest percentage of total nitrogen. The maximum content of total nitrogen obtained was about 3.9 percent.

**Studies on the Quantitative Estimation of Hemicelluloses.** (Emmett Bennett.) Procedures relating to the development of a method for the quantitative estimation of polyuronide hemicelluloses have been continued. The technique adopted is based on the action of sodium chlorite on plant tissue. After certain preliminary extractions, this reagent removes the lignin to almost any desired extent, leaving behind the hemicelluloses. This group of substances may in turn be removed by extraction with relatively dilute solutions of strong alkali. The extracts are then oxidized in a solution of chromate in sulfuric acid. The reduced chromate is measured spectrophotometrically. By referring to a curve which relates reduced chromate to anhydropentose, the content of hemicellulose as anhydropentose may be ascertained.

In the case of cornstalks, extractions were found to be most efficient when the tissue was mercerized with 14 percent sodium hydroxide at 20° C. for ten minutes, then an equal volume of water added and allowed to stand for a total of 90 minutes. Approximately 85 percent of the furfuraldehyde-yielding substances may be removed in this way. It is also quite probable that such a partition separates the polyuronide from the cellulose hemicellulose. It is felt that more drastic treatment is undesirable since some pentose units might be removed from the cellulose chains. It seems more desirable to consider such units as constituents of cellulose.

Pectic compounds and ether-soluble substances should be removed prior to treatment with sodium chlorite. Starch, to some extent at least, is solubilized by the action of this reagent. Protein is not removed completely during the production of holocellulose, but is extracted almost completely by the alkaline medium; hence corrections must be applied in obtaining the final figure for hemicelluloses.

The procedure has been applied to six different plant tissues with a hemicellulose content ranging from about 7 to 25 percent. Consistent results can usually be obtained and variations between samples usually do not exceed 5 percent. It is believed that the simplicity, rapidity, and consistency of the procedure will make it of value.

**The Chemical Investigations of Hemicelluloses.** (Emmett Bennett.) Investigations dealing with the chemistry of hemicelluloses have been continued. Special attention has been given the hemicelluloses of cornstalks. This fraction was obtained from holocellulose prepared according to a previous report (Jour. Ind. Eng. Chem. Anal. Ed. 19, 215, 1947). To date solubility studies have been made and some of the fractions characterized by certain determinations. All solvents used extracted some hemicellulose, but the bulk was freed by the action of 4 percent sodium hydroxide at room temperature. All fractions tested were optically active and ranged from about  $-60^\circ$  to  $-85^\circ$ . The more negative rotations were associated with the higher content of pentosans. Methoxyl and

uronic acids were present and decreased in amount as the content of pentosans increased. The magnitude of the alkali lability numbers would indicate that there is little difference in the chain length of the fractions obtained by use of the stronger reagents. Further interpretations are not in order at this time.

**The Influence of Base Exchange Capacity and of Exchangeable Ions in Massachusetts Soils on the Availability of Potassium.** (Dale H. Sieling.) Tobacco plants grown on soils of varying base exchange capacities (B.E.C.) and available potassium levels in 1942 were analyzed for calcium (Ca), magnesium (Mg), and potassium (K). Tobacco was grown on these same soils in 1946 to further exhaust the soils of cations and to determine the influence of B.E.C. on the availability of these residual bases. The plants produced were analyzed for Ca, Mg, and K.

From 50 to 60 percent of the available K was absorbed by the growing crop during the first season. The amount of K absorbed was closely proportional to the K present in the soil, and not related to the available Ca or the B.E.C. The dry weight production closely paralleled the K availability. In the second year the plants developed severe potash-deficiency symptoms and absorbed very much less K. In general, the second crop absorbed greater amounts of K from those cultures of high B.E.C.

Ca was absorbed in greater quantities from soils of high B.E.C. than from soils of low B.E.C. The relative amount of Ca to total bases absorbed was greater during the second year than during the first year. In all instances, an increase in K uptake resulted in a decrease in Ca uptake and a greater dry weight production.

The proportion of Mg to total bases utilized decreased significantly as the uptake of K increased. No significant effect on Mg uptake was shown by variations in the Ca level of the soil or the B.E.C.

There was a general tendency for the total phosphorus content of the plant material to decrease as the Mg/total cation ratio decreased.

In general, cation uptake and maximum growth was associated with soils of high B.E.C., and in turn less bases were lost by leaching from soils of high B.E.C. Therefore agronomic practices tending to increase the B.E.C. should be practical. Increase in available K in soils definitely favored the uptake of K by the plants with the subsequent decrease in the uptake of Ca and Mg. Increase of Ca, on the other hand, did not decrease the uptake of K but resulted in a higher total base uptake. The greatest dry weight production was associated with the widest K/Ca, K/Mg, and Ca/Mg ratios in the dried plant material. It therefore seems reasonable to suggest that the use of fertilizers high in K should be supplemented with liberal applications of Ca and Mg to prevent the induction of deficiencies of either of these elements as a result of luxury consumption of K.

**The Fixation of Arsenic in Soils and the Influence of Arsenic Compounds on the Liberation of Fixed Phosphorus in Soils.** (Dale H. Sieling.) Kaolin is a widely distributed soil mineral which has been said to have ability to fix phosphates in large quantities, especially after it has been reduced to a fine state by grinding or other means. It was found that kaolin could be activated to adsorb large quantities of either phosphate or arsenate by ball-milling it or heating it with an alkali metal hydroxide. The longer the time of ball-milling or the greater the amount of alkali hydroxide used per unit of kaolin, the greater was the sorption capacity of the activated kaolin.

The active constituent of ball-milled and alkali-activated kaolin could be removed by extracting the materials with 0.1N HCl, 0.1M tartaric acid, or 10 percent HCl. This active constituent was believed to be a hydrous alumina such

as gamma -  $\text{AlOOH}$  which is known to be present in freshly precipitated alumina and to exhibit properties similar to the ball-milled kaolin.

The alumina of ball-milled kaolin sorbed phosphate and arsenate in practically equivalent amounts from the more dilute solutions of these ions; however, from the more concentrated solutions the sorption of arsenate far exceeded that of phosphate. The amount of either anion sorbed was dependent upon the reaction of the equilibrium solution and the initial concentration of the solution. The lower the pH within the range of pH 3.0 to pH 7.0, the greater the sorption; and the higher the concentration at any fixed pH, the more of the anion was sorbed per unit of alumina.

Freshly precipitated hydrous alumina sorbed phosphate and arsenate in greater quantities than an equivalent quantity of alumina contained in ball-milled kaolin. Freshly prepared anhydrous alumina was much less active in anion sorption than the alumina of ball-milled kaolin. Aged commercial "aluminum hydroxide" had no anion sorption activity unless it had been activated by alkali and heat.

Phosphates were effective in replacing sorbed arsenate from the alumina of ball-milled kaolin, but the reaction was not an equivalent one. Arsenates replaced only a very small percentage of the sorbed phosphates from the alumina of the ball-milled kaolin even when the concentration of the arsenate was five times that of the sorbed phosphate. Therefore, the use of arsenate as an analytical reagent for measuring the anion sorption of soils or for determining the exchangeable phosphorus in soils is not recommended. It follows also that soils which have received large quantities of arsenates as a result of measures used in pest control might release quantities of arsenates toxic to plants if they were heavily fertilized with phosphatic materials.

**The Effect of Orchard Mulches on Plant Nutrient Elements in the Soil.** (Dale H. Sieling and Jacob K. Shaw.) Six mature McIntosh apple trees which had been managed by the cultivation-complete fertilizer system from 1931 through 1940 were selected for this study in June 1941. Six separate plots, each with an area of 1600 square feet and containing one tree at its center, were treated as follows: Duplicate plots received an application of 290 pounds, 417 pounds, 350 pounds, and 400 pounds of dry mixed-hay mulch in 1941, 1942, 1943, and 1944 respectively; duplicate plots received a mulch of fiber glass wool 2-3 inches in thickness in 1941; and two plots were cultivated and kept fallow. No commercial fertilizer was applied to any of the plots during the six years the investigation has been in operation.

Soil samples were taken at two systematically located positions under each tree before the mulch was applied. At each sampling location four samples were taken at the following depths: 1-3 inches, 6-8 inches, 12-14 inches, and 22-24 inches. This sampling procedure was repeated in 1942, 1943, 1944, and 1947 from newly selected positions not far removed from those of the previous year but far enough to insure the obtaining of the samples from soil which had not been disturbed by previous samplings. The mulch was removed from the sampling areas before sampling time to prevent its incorporation in the surface soil samples. The samples were stored in sealed containers and were analyzed for exchangeable calcium, magnesium, and potassium to find whether the mulching systems employed were effecting the movement of these cations into soil.

The hay used for mulching was analyzed for calcium, magnesium, and potassium and was found to vary considerably from year to year. In total, 34.3 pounds of calcium, 2.7 pounds of magnesium, and 21.7 pounds of potassium were added as mulch to each plot of 1600 square feet or at the rate of 933 pounds, 73.4 pounds, and 590 pounds of these elements per acre respectively.

The amount of these elements added as the mulch should, when the hay was mineralized, have had a significant effect upon the amounts in the upper zones of



the soil beneath the mulch, provided the tree had not effectively removed the major portions of them as the mineralization took place.

Analysis of the soils for these elements revealed that the variations between the duplicate samples obtained from the various plots during any sampling period were much greater than the variations caused by the elements added in the mulch. Therefore it is not possible to say that the mulching procedure was effective in mobilizing or increasing the exchangeable calcium, magnesium, or potassium, although trees under hay mulch were superior in performance and appearance to the trees receiving the other two treatments.

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## THE CRANBERRY STATION

East Wareham, Massachusetts

H. J. Franklin in Charge

**Administration.** Pursuant to providing acts of the legislature, considerable office changes were made in the main building of the station to accommodate increased personnel, an oil-burning plant was installed in the basement for heating the laboratory and offices, much new laboratory equipment was added, and a new full-time clerk was employed. These provisions should greatly increase the efficiency of the station and make it possible to finish in reasonable time some important lines of work that have long been in process.

**General.** An unusual combination of circumstances produced a large crop of cranberries in Massachusetts and the country as a whole in 1946, and there was a remarkable market demand for the fruit at record high prices. The state bog crop was the largest since that of 1923 and is returning nearly 32,000 dollars to the State Treasury.

Notable features of the 1946 cranberry season in Massachusetts were a very unseasonable frost on July 16-17 which destroyed over 1200 barrels of berries, mostly in Holliston, Plymouth, Waquoit, Santuit, Wakeby, and Brewster; and excessive rain in August (12.61 inches at East Wareham) that caused bogs to be flooded to such an extent that, as estimated, 15,000 barrels of berries were ruined. The berries of the Massachusetts crop proved to have very good keeping quality in spite of this rain.

**Injurious and Beneficial Insects Affecting the Cranberry.** (H. J. Franklin.) Bulletin 239 was revised and amplified and presented for republication.

**DDT.** Investigations made in 1946 indicated that this insecticide is effective against the cranberry tipworm and the cranberry weevil, and it was advocated as a control for these insects as well as for the gypsy moth and the black-headed fireworm in the 1947 Cranberry Insect and Disease Control Chart.

**Chlordane** ( $C_{10}H_6Cl_8$ ) used both as a dust and in a spray was not nearly so effective as DDT as a control for gypsy moth caterpillars and blunt-nosed leafhoppers (*Ophiola*).

**Helicopters.** Observations of these machines in commercial operations against cranberry pests in the spring and early summer of 1947 lead to the conclusion that they are likely to soon come into general use on Massachusetts bogs.

*Prevalance of Cranberry Insects in the Season of 1946:*

1. Gypsy moth infestation moderate in Plymouth County and inland; very light in Barnstable County.

2. Leafhoppers (*Ophiola*) not very abundant.

3. Fruitworm infestation very light, rather lighter than in 1945.

4. Black-headed fireworm not very troublesome.

5. Very few fire beetles (*Cryptocephalus*) found.

6. Spotted fireworms (*Cacoecia*) very few.

7. Spanworms, both green and brown, about as usual.

8. False armyworm infestation about normal.

9. Cranberry girdler (*Crambus*) still much more troublesome than before the war, owing to neglect of bog resanding.

10. Spittle insect about as usual.

11. Tipworm apparently very much more prevalent generally than usual. Probably partly as a result of this, the average terminal budding of the vines for the 1947 crop on the bogs in this State was the poorest observed by the writer in his forty years of cranberry experience.

12. Bumblebees and honeybees were unusually abundant on the bogs everywhere throughout the cranberry flowering. A very remarkable and possibly very instructive incident relative to bee abundance was observed. The winter flowage was removed from a bog of two and a half acres in East Carver on June 20. This bog reached full bloom about August 8. Bumblebee workers and males came to this bog in astonishing numbers whenever the weather was fair throughout the blooming. It was estimated that a third of a million of these bees were there much of the time. Watching them at work, as they rose from the cranberry vines and went back to them here and then there, gave one the strange feeling that he was looking out on a bumblebee sea. Honeybees seemed to be entirely absent. The fruit, about 180 barrels of Early Black berries of fair size and color, was gathered from this bog early in October.

**Frost Forecasts.** These are continued as a special service, with the 1947 charges for the telephone service increased materially over those of previous years to meet the larger costs caused partly by improvements. About 7200 acres of bog in the hands of 204 subscribers are covered by the telephone warnings, this being about three-fourths of the entire Massachusetts cranberry acreage with fair to full flowage protection. The accessory warning service by radio is co-operating as heretofore with the United States Weather Bureau office at Logan Airport, the warnings being given mainly through station WEEI at Boston.

**Control of Cranberry Bog Weeds.** (C. E. Cross.) A large number of experiments have been set out on the State bog and other bogs since May 1, 1946, the results of which have not been previously reported.

1. In the belief that one of the greatest weed problems faced by cranberry growers is that of controlling grasses and sedges which begin their season's growth after the cranberry vines have started, many tests were made in July and August, 1946, with kerosene oils, Stoddard solvent, insecticide base oils, and a large number of strictly experimental oils known only by numerical designation. None of these oils has, as yet, proved satisfactory as a selective weed killer during the summer season.

2. Stoddard solvent, sprayed at 400 gallons per acre during the first two weeks of May has been found an excellent selective killer of asters. Kerosene at 1000 gallons per acre will not kill asters nearly as effectively, though neither treatment injured cranberry vines or buds when applied before May 15. The Stoddard solvent treatment is more effective, more easily applied, less injurious to vines,

and less expensive than the previously recommended control of asters with ferrous sulfate.

3. Paradichlorobenzene, scattered at  $7\frac{1}{2}$  pounds per square rod and covered immediately with an inch of sand, has previously been recommended for controlling poison ivy, chokeberry, loosestrife, and white violets. Experiments now show this treatment to be effective against wild bean (*Apios*) and three-square grass (*Scirpus*), and occasionally against the small bramble (*Rubus*). In addition, this treatment was found effective against poison ivy and wild bean when applied early in April while ivy and bean were still dormant.

4. Ferrous sulfate can be spread at the rate of 50 pounds per square rod without injuring cranberry vines. This heavy application, made in June, July, or August, killed all white violets, asters, and needle grass. However, serious injury to cranberry vines resulted when this treatment was applied to bogs sanded within a year. Tender cranberry roots near the surface in the new sand were apparently severely burned.

Some study and experimental work has been done toward protecting cranberry bogs from winterkilling and frost by means other than flooding. This work looks promising but is still in its preliminary stages and will not be described more fully now.

**Cranberry Breeding.** (F. B. Chandler, Collaborator; H. F. Bergman, U.S.D.A.) One hundred and fourteen selections from the 10,685 cranberry seedlings produced by the U.S.D.A. have been set in Massachusetts for further testing: some in four bogs, and the others in two or three bogs. From these selections, it is hoped that some new varieties will be developed which will be resistant to false blossom and fungous diseases and will give good yields of desirable fruit.

The results of the breeding work and some of the information about these selections were published in *Cranberries* for May and June, 1947.

**Fertilizer Requirements of Cranberry Plants.** (F. B. Chandler and Wm. G. Colby.) Plots have been laid out and fertilizer applied to study nitrate vs. ammonia as a source of nitrogen for cranberries. The rate of application of nitrogen in the treated plots has varied from 10 to 80 pounds per acre. Fertilizer applications are being made before bloom (June), before fruit-bud formation (late July), late in the fall, and early in the spring. These plots have not been established long enough to give information on yield, but vines on fertilized plots have much better vigor and bloom and are much heavier than vines on unfertilized plots on both hard-bottom and peat-bottom bogs.

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## DEPARTMENT OF DAIRY INDUSTRY

H. G. Lindquist in Charge

**Sanitizing Agents for Dairy Use.** (W. S. Mueller.) Since the last war many new sanitizing products are available for dairy use. In general these new products, both liquids and powders, have in common a quaternary ammonium salt of one form or another, which is the active bactericidal material. The effectiveness of these new sanitizing agents for dairy use is being investigated and the following progress has been made:

1. *Bactericidal Properties of Some Surface-Active Agents.* (W. S. Mueller with the cooperation of Emmett Bennett of the Chemistry Department and J. E. Fuller of the Bacteriology Department.) Results of this study were published in the *Journal of Dairy Science* 29, November 1946. It was concluded that out



of 42 surface-active agents investigated, only the quaternary ammonium salts showed considerable promise of making a good sanitizing agent for dairy use.

2. *A Method for Evaluating the Sanitizing Efficiency of Quaternary Ammonium Compounds.* (W. S. Mueller and E. P. Larkin.) A method has been developed for evaluating the sanitizing properties of quaternary ammonium compounds. While the method is not new, it involves the use of some new procedures and some refinements of older techniques. In brief, the method consists of the addition of a standardized inoculum to a germicide, and the results are simply reported as percentage survival or kill for definite periods of contact time. The usefulness of this method depends largely upon the efficiency of the inactivator. A hand homogenizer and spectrophotometer are used in preparing the inoculum, and sodium naphthuride is used as the inactivator for the quaternaries. This method appears to give a truer picture of the germicidal potency under actual working conditions than is given by the phenol coefficient values as determined by the Food and Drug Administration method.

3. *The Use of Quaternary Ammonium Compounds in Dairy Sanitation.* (W. S. Mueller and D. B. Seeley.) Organisms like *E. coli*, *S. aureus*, thermophilic types, and the vegetative cells of *B. cereus* were readily killed by quaternaries. While quaternaries appeared to have no greater germicidal effect on spores of *B. cereus* and thermodurics than older types of germicides, they were highly bacteriostatic to sporeformers.

Approximately 0.3 percent of either cow manure or non-fat milk solids produced the first significant decrease in germicidal potency of a 200 p.p.m. quaternary solution. When this concentration of quaternary was used as an udder wash under normal conditions, approximately 30 to 40 cows could be washed before the germicidal potency of the solution decreased to a point where a fresh solution was needed. No chapping or cracking of udders, teats, or milkers' hands was noted when this concentration of quaternary was used.

Metal parts of dairy equipment, when properly washed, were effectively sanitized by the use of 200 p.p.m. of quaternary. However, as much as 400 p.p.m. was not effective in sanitizing the rubber inflation tubes of teat cups after each cow milked when the cups were dipped rapidly in and out of the solution.

A quaternary spray treatment for milk cans showed a significant reduction in counts.

Dual-purpose powders such as cleaner-sanitizer combinations appear to have considerable merit.

4. *The Effect of Quaternary Ammonium Compounds on Molds.* (W. S. Mueller and R. S. McKenzie.) Considerably less work has been done with quaternary ammonium compounds in connection with molds than with bacteria. The chief purpose of this study is to determine what effect quaternary ammonium salts have on some molds commonly found in milk, cream, butter, sweetened condensed milk, and cheese. While work on this study has not progressed far enough for definite conclusions to be drawn, it is evident that not all molds are destroyed after five-minute contact with a 200 p.p.m. quaternary solution at room temperature.

**Antioxidants from Cacao.** (W. S. Mueller.) Improvements have been made in the extraction of certain tannin-like antioxidants from cacao, thus making it possible to obtain antioxidants of greater purity. The refined products obtained were found to be more effective than the earlier extracts in improving the stability of butter oil, according to peroxide value, color, taste, and odor tests. The refined antioxidants also were more effective in retarding the destruction of vitamin

A and in neutralizing the pro-oxidant effect of copper. If the stability data which have been obtained on butter oil by accelerated tests can be applied to food products containing butter fat, then the food value, flavor, and keeping properties of such products should be greatly improved by the use of the anti-oxidant in question.

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## DEPARTMENT OF ECONOMICS

Philip L. Gamble in Charge

**Effects of the War and Readjustments in Massachusetts Agriculture.** (David Rozman.) Further studies were made of wartime changes in the pattern of agricultural production and their effect on the needed readjustment in the coming years. Analysis of the AAA records together with other supplementary material, provided a valuable basis for determining the changes in farming enterprises on individual farms. In the light of the investigations made under this project the 1947 production program was worked out for Massachusetts agriculture.

In connection with the problems of postwar adjustment in agricultural production, an analysis has been made of the changes in major farming enterprises in the period from 1942 to 1945 inclusive. On 2374 operating farms analyzed in five counties, the following changes in livestock numbers and crop acreages occurred: All cattle and calves increased 4.9 percent; hens and pullets for laying increased 53.7 percent; corn acreage declined 8.2 percent; vegetable acreage declined 0.5 percent; potato acreage increased 16.5 percent; tobacco acreage increased 20.8 percent. This presents the situation on the farms remaining in continuous operation through the war period. To the extent that a certain number of other farms in the State might have discontinued their operation on account of difficulties in production or for some other reason, indicated changes in various lines would need some adjustment to reflect the situation on a statewide basis.

**Transfer of Ownership and its Effect on Agricultural Land Utilization.** (David Rozman.) Work on this project commenced at the beginning of 1947 and is yet in preliminary stages. The main objective is to appraise the effect of changing ownership on land utilization and the future trend of farming in the State. From the preliminary evidence already obtained it appears that the rate of transfer of agricultural land during the war and immediately following has been accelerated by an increased demand from various sources. The character of new ownership will have a direct bearing on the size and kind of farms and their variations from the recognized standards of an efficient economic unit. Its ultimate effect will be to determine the pattern of agricultural production as it will emerge in the State in the coming years.

To obtain a representative sample of localities for investigation, a number of towns have been considered as to their suitability. In Hampshire County, Amherst and Hatfield have been selected. From the Registry of Deeds and from assessors' records complete information was obtained as to the transfer of land ownership in agricultural areas of these towns from the beginning of 1940 to the end of 1946. In addition to land areas and names of the parties in the transactions, the information obtained includes detailed classification and valuation of property; prices paid, if given; mortgages; and the numbers and kinds of livestock maintained on the land.

## DEPARTMENT OF ENTOMOLOGY

Charles P. Alexander in Charge

**Investigation of Materials which Promise Value in Insect Control.** (A. I. Bourne and W. D. Whitcomb.) Work in connection with the cooperative project with the Dow Chemical Company was continued in 1946, both at Amherst and Waltham.

Dormant applications of the experimental compounds D-608, D-610, D-542, D-289 and D-2 on apples, all gave excellent kill of overwintering eggs of apple plant lice. Aphids on sprayed trees averaged two or less per bud as contrasted with 50 per bud on unsprayed checks. There was also measurable reduction of European red mites on sprayed trees.

Pear psylla was very satisfactorily checked by D-542 and D-2. Eggs deposited on sprayed trees averaged less than 3 per fruit spur as contrasted with 80-85 on unsprayed trees. No further control measures were necessary on most of the pear orchard throughout the balance of the season.

D-542 on *Viburnum* prevented appearance of aphids on this ornamental shrub and for the first time in many years the specimens which received this spray produced a full bloom, and the unsightly appearance of distorted leaves and twigs was avoided.

At Waltham applications of experimental dinitro formulations prepared by the Dow Chemical Company were applied to 20-year-old apple trees when buds were in the silver-tip stage. The formulae were known as D-608, D-610, and D-289; and were diluted for spraying at 2 percent, 2 percent, and 2 quarts per 100 gallons respectively. Examinations on May 2 when the center bud was open showed no rosy aphids, green aphids, or newly hatched European red mite on any of the trees, including those unsprayed. Where D-610 at 2 percent was used, very slight but insignificant injury to the most advanced fruit buds was found. No injury was observed from the other formulae.

Orchard tests of a miticidal DDT containing 20 percent hydroxy penta methyl flavan were made at Waltham and in cooperation with orchardists at Bolton, Groton, and Westford, Massachusetts. When this material was used at the rate of 5 pounds in 100 gallons of spray, careful leaf counts showed a reduction in the mite population varying from 60 to 80 percent after two applications. However, red mite eggs were not killed and there was no toxic residue to prevent a serious reinfestation in two or three weeks.

**DDT for Control of Black Scale on Gardenias in a Commercial Greenhouse.** (A. I. Bourne.) The black scale (*Aspidiotus perniciosus*), a native of tropical and sub-tropical regions, occurs on many types of trees and shrubs and is one of the most serious insect pests of citrus fruits. In Massachusetts and other northern areas, it is almost entirely a pest of greenhouse plants. This scale is so prolific and has such a wide range of plants upon which it will thrive, that it is always a dangerous pest and, when well established, has proved very difficult to control. Aside from the direct damage from its feeding, the honeydew excreted by the scales serves as an excellent medium for the growth of sooty fungus. On many greenhouse crops such accumulation of black, sooty fungus on the foliage constitutes a depreciation in value second only to that caused by reduction of bloom. All these factors combine to make this species one to be dreaded by all commercial growers who encounter it in their houses.



On September 16, attention was called to a serious outbreak of black scale on Gardenias in a commercial greenhouse. The infestation occurred in both sections of one range, comprising a total of 60,000 square feet. The plants were in their second year of growth and were coming into their first season of full production. Scale was present throughout both houses but the heaviest attack was centered in the three south benches of the east house. On many plants both buds and leaves were heavily infested and much of the foliage was coated with sooty fungus. Examination of sample leaves from the house showed an average of 56.5 crawling young and 54.8 older stage scales per leaf, or a total of 111.3 scales per leaf.

On this same date a 25-foot section of one bench in the area of heaviest infestation was given a spray of a 25 percent DDT emulsion at 1:250 dilution. The rest of the eastern half of the house was sprayed with nicotine sulfate 1:500 + fish oil soap 4 pounds per 100 gallons, on September 17, 24, and at 7 to 10 day intervals thereafter.

One application of the DDT emulsion reduced the number of scales from an average of 111 per leaf to 2, within two days, and held it at approximately the same figure for three months. In the meantime weekly applications of nicotine sulfate failed to prevent an increase in the number of scales so that by late October it was necessary to make an application of DDT emulsion to the whole house to prevent serious damage to the plants. By this time, in this area, leaves and buds had become heavily infested (average 150 scales per leaf). The small number of scales in the section sprayed with DDT (average 1.6 scales per leaf) indicated how completely the pest had been controlled in that section. Both leaves and buds were practically clear of scales. The new, terminal growth was noticeably greater and the plants were in much more vigorous condition. Moreover, the DDT emulsion left no white deposit on the foliage, an objectionable feature of the use of DDT in the form of wettable powder.

**The Value of Control Measures to Supplement the Standard Spray Program for Apple Pests in Massachusetts.** (A. I. Bourne, in cooperation with the Departments of Pomology and Plant Pathology.) Injury from frost so reduced the set of fruit that it was necessary to rearrange the location of the spray tests.

In the orchard where the lead arsenate tests were made, the set of fruit was very light on the unsprayed check trees. They were in an exposed section of the orchard and suffered greatly from frost damage. There was also a heavy drop from disease and insect attack. All of the apples on these trees were blemished by scab; 50 percent were scarred by curculio; 67 percent were damaged by codling moth (blossom end and side worm "stings"); and about 33 percent showed scarring by minor pests and were infested by apple maggot.

The regular schedule, with lead arsenate the insecticide, held codling moth to 16 percent injury and curculio to  $6\frac{1}{2}$  percent, and reduced scab to 19 percent damage. When the emergency codling moth spray was interposed between the 2d and 3d cover spray, codling moth and minor insect pest damage was cut down to a mere trace, and this extra application reduced scab to 11 percent blemished fruit in a season of unusually heavy attack. The application of a mid-August spray did not give any measurable additional reduction of codling moth.

Results would indicate that if the emergency spray is carefully timed on codling moth development, no other additional spray is required, and that the increased protection from scab afforded by this spray would also justify its use.

In the orchard to which the tests with DDT were transferred, the test blocks received the regular schedule up through the calyx and first cover spray. In the

2d cover spray, all the sprayed rows received lead arsenate 2 pounds + fungicide. In addition row 1 received DDT  $\frac{1}{2}$  pound (actual); row 2 received DDT 1 pound; and row 7 received DDT 2 pounds. Row 5 was left as a check. In the emergency A spray and the 3d cover, the sprayed rows received the DDT as in the 2d cover, but lead arsenate was omitted. In the 4th cover, lead arsenate 2 pounds + fungicide was used, but no DDT.

Because of frost damage, the yield on the check row of McIntosh was too light to be worth considering, so that the fruit on Cortland variety was checked.

Codling moth was not as severe a pest as usual in many of the orchards in 1946, but in the DDT blocks it was practically nil (about 3 apples in 500). The heavy dosage of DDT (2 pounds actual) + lead arsenate (2 pounds) in the 2d cover spray evidently cut curculio damage materially. This conformed with results of tests in other orchards. The effectiveness of DDT was also reflected in the protection against apple maggot and miscellaneous apple pests, all of which were reduced to a mere trace; actually only a matter of an occasional apple per bushel. It was also encouraging that in a season of unusual severity of scab, the combination of DDT with wettable sulfur fungicide not only proved compatible but gave excellent protection of the fruit from scab.

**Insecticides for the Control of the European Corn Borer.** (A. I. Bourne.) The first brood, corn borer infestation in Massachusetts was very light in 1946 and occurred somewhat later than usual.

Cold, windy weather which prevailed through most of May appeared to be very unfavorable for moth activity. Early plantings of corn developed rather slowly, and without doubt many moths in the field emerged before corn was up or was of attractive size. This was certainly true of material in the emergence cages. Probably many moths died without depositing eggs, which seems to be borne out by the insignificant infestation on early sweet corn since there was a moderately heavy carryover and almost no winter mortality.

Throughout most of the State damage by first-brood larvae was negligible even in untreated fields. Severe drought from mid-June to late July may have contributed one factor, since considerable rolling of the leaves occurred in many fields and egg masses are easily dislodged, especially when rolling is accompanied by hot, drying winds, such as occurred in 1946. The growth of corn was slowed down and early plantings were late in maturing. Many fields planted by mid-April or earlier, and breaking ground by late April, did not mature until early August.

The second brood was also somewhat delayed and in general was not serious.

In the field tests, applications were made at 7-day intervals. Evidently this was too far apart for securing best results from derris, although it appeared to be satisfactory for the other materials. Ryanex both as a spray and as a dust gave very satisfactory control and caused no injury. Applications of DDT and DDD were followed by slight burning.

Of the sprays, Ryanex, DDT (1 pound actual), and DDD (1 pound actual) gave 98-99 percent control. Derris (4 percent rotenone) gave 95.5 percent clean corn. Of the dust materials, DDT (3 percent) gave practically complete protection, Fixed Nicotine Dust (4 percent nicotine) 97 percent, and Ryanex 94 percent.

**Potato Spraying Experiments.** (A. I. Bourne.) The plots were planted May 9 and the plants made normal and satisfactory progress throughout the early season. The plots were partially submerged by the heavy rains in late July when 4 to 5 inches of rain fell within about two days' time. Rains thereafter kept most of

the field rather wet and checked growth somewhat. Most of the plants remained alive and green until killed by frost October 13-14 (the first serious killing frost). The field was dug October 14. Damage from excessive water was such that records could be taken only from the higher portion of the field.

Flea beetles were slightly less than normal in abundance; the early attack was very light. A rapid and heavy build-up of leafhoppers occurred between July 17 and 25. One application of DDT (1 pound actual) in 10-5-100 Bordeaux on the 25th not only practically eliminated leafhoppers but wiped out the late brood of flea beetles; neither insect was present in any amount for the remainder of the season. Potato aphids began to appear in all plots about mid-July during the hot dry weather which prevailed at that time. The infestation was subdued with nicotine sulfate in the application of July 17. The records indicate that the application of DDT practically eliminated insect pests with the exception of potato aphids, and even in the case of potato aphids prevented a serious build-up. By mid-August practically all insects had been eliminated and the insignificant damage to foliage was shown by records of flea beetle perforations on the foliage: 6.4 punctures per growing tip on August 17 and 2.5 punctures per growing tip on August 20.

Sprays were applied at approximately 7-day intervals from June 12 when the plants were about 4 to 6 inches high until September 18 when most of the plants were still green but were beginning to ripen. The sprays from August 28 were for protection of green tips only. There was practically no evidence of insect presence after early August.

Evidence from these tests, as well as results of experiments elsewhere, indicate that DDT is very effective against the major insect pests of potato. In laboratory and field tests, DDT either as a dust or as a spray controlled Colorado potato beetle, leafhoppers, flea beetles, and plant bugs, if thoroughly applied to reach both upper and under leaf surfaces. There is indication that potato aphids can be held to low numbers by a regular schedule of DDT, although there is still some doubt whether heavy outbreaks will be checked quickly enough to prevent damage when DDT dusts or wettable powders are used.

**Control of Onion Thrips.** (A. I. Bourne.) The test plots were planted to onion sets April 18. Cool dry weather slowed early development somewhat, but with plentiful rainfall in May and early June, growth was more normal and the plants made rapid advance. The growth was checked somewhat by the 5-week period of dry weather which followed. The plants had become well established by mid-June so that the check was not serious, and the plots matured a good crop which was ready to harvest by early August.

Thrips were delayed somewhat in early spring by the cold weather but found the hot dry weather of late June and July very favorable, and built up rapidly. Throughout the Connecticut Valley, thrips were not of serious abundance; set onions escaped any appreciable injury, and the small plantings of seed onions were not seriously attacked.

Black Leaf 40 and derris sprays again gave consistently high control in all cases. Ryanex, DDT, and DDD sprays also proved effective (above 90 percent effective control). DDT and DDD were superior to the other sprays in residual effects, allowing no increase in thrips population during a 7-day period following application.

Of the dusts, Multicide and Multicide + pyrethrum gave a consistently high degree of immediate protection and good residual effects. Following a very heavy



application, sabadilla gave very good control but appeared to have very little residual value. Ryanex dust appeared to kill rather slowly but to furnish good lasting effects. DDT dusted plants showed even fewer thrips after a 7-day interval than 24 hours after the application.

None of the sprays or dusts used caused any plant injury.

**Control of Squash Vine Borer.** (W. D. Whitcomb, Waltham.) Experimental plantings in 1946 verified previous observations that varieties of *Cucurbita moschata* are immune to squash vine borer. Three varieties of *C. maxima* averaged 2.88 borers per vine, and three varieties of *C. pepo* averaged 1.70 borers per vine.

Insecticide applications in July with 3 percent DDT-talc dust, 20 percent sabadilla-lime dust, and  $\frac{1}{2}$  percent DDT plus 0.06 pyrethrins dust gave satisfactory protection; while applications of 10 percent sabadilla-lime dust and  $\frac{1}{2}$  percent DDT-talc dust were unsatisfactory as used.

A 5 percent benzene hexachloride-talc dust applied while the plants were small caused so much injury that it was necessary to replant. The 3 percent DDT-talc dust caused slight temporary stunting to seedlings, which was most evident on cucumbers and least evident on Blue Hubbard squash.

**Control of Cabbage Maggot.** (W. D. Whitcomb, Waltham.) Field treatments for the control of the cabbage maggot in early Golden Acre cabbage were compared with a natural 100 percent infestation on untreated plants, in which 84 percent of the plants were commercially damaged. DDT-talc dust, both 3 and 5 percent DDT, applied either with a hand duster in two applications at a weekly interval, or placed in a mound around the stem of the plant soon after the first eggs were laid, permitted 20 to 25 percent infestation and from 20 to 40 percent of the heads were unmarketable. Corrosive sublimate solution 1-1,280 in two applications, and 4 percent calomel-talc dust in a mound around the stem gave perfect protection from commercial injury. However, the outstanding treatment was two applications with a hand duster of benzene hexachloride-talc dust containing about 5 percent of the gamma isomer. This dust completely controlled the maggot on both cabbage and cauliflower as well as preventing blind heads due to cutworm injury. No evidence of contamination by the odor of the insecticide was evident at any time after the heads began to form. This treatment promises to have great commercial application.

**Biology and Control of Red Spider Mite on Greenhouse Crops.** (W. D. Whitcomb, Wm. Garland, and C. S. Hood, Waltham.) Spraying of greenhouse roses with hexa ethyl tetra phosphate solution resulted in excellent control of greenhouse red spider, but caused some injury to foliage and stunted the growth of the petals on the outside of rosebuds. Two commercial brands of this material diluted as recommended were equally effective and caused similar plant injury.

The effect of sodium selenate in red spider control was studied on potted carnations at low temperatures (55° F.) during the winter. Dosages of  $\frac{1}{2}$  gram,  $\frac{3}{4}$  gram, and 1 gram per square foot caused a reduction in the spider population 50 days after treatment, and remained effective for 50 days longer (100 days after application). A dosage of  $\frac{1}{4}$  gram per square foot became noticeably effective 60 days after application and remained effective only 30 days. Spider populations were not reduced as much by the dosages used as they were by similar treatments in spring and summer.

**Apple Maggot Emergence.** (W. D. Whitcomb, Waltham.) Apple maggot fly emergence in cages at Waltham occurred at about the normal period in 1946 although the number of maggots which survived the winter and transformed was low. Emergence peaks occurred at two periods, July 7 and 25, which verified the estimated dates for control by spraying. The emergence in two orchard cages was:

First fly emerged.....	June 29, 1946
25 percent of flies emerged.....	July 7-11
50 percent of flies emerged.....	July 14-22
75 percent of flies emerged.....	July 24-27
Last fly emerged.....	August 20
Percent of expected emergence.....	68.8
Percent of possible emergence.....	34.1

**Control of Plum Curculio in Apples.** (W. D. Whitcomb, Waltham.) Although laboratory poison studies with plum curculio beetles confined with sprayed apples indicated reasonable control with DDT water suspensions containing more than 1 pound DDT per 100 gallons, orchard experiments with  $1\frac{1}{2}$  pounds DDT per 100 gallons were unsatisfactory. Two commercial brands of DDT wettable powder were compared, with almost identical results; namely, 48.47 and 48.54 percent of the apples stung by curculio.

A 50 percent hexachlorocyclohexane wettable powder containing 5+ percent gamma isomer combined with wettable sulfur failed to control the plum curculio (61.06 percent total fruit and 49.91 percent harvest fruit stung), when used in the regular schedule of applications. It was evident from observations, however, that more frequent applications would have been significantly more effective. Each of the following combination treatments was significantly more effective than lead arsenate alone in the same schedule, as shown by the percentage of harvest fruit free from stings.

Lead arsenate	4 pounds.....	75.71
Lead arsenate	4 pounds + DDT 50 wettable 2 pounds.....	97.31
Lead arsenate	2 pounds + DDT 50 wettable 2 pounds.....	87.62
Lead arsenate	4 pounds + BHC 50 wettable 2 pounds.....	86.90
DDT 50 wettable 2 pounds + BHC 50 wettable 2 pounds.....		86.51

This is the second season when sprays containing combinations of insecticides have been outstandingly effective for control of the plum curculio, and significant evidence of their practical value is rapidly accumulating.

**Naphthalene and Similar Compounds as Greenhouse Fumigants.** (W. D. Whitcomb and Wm. Garland, Waltham.) Several materials were used experimentally for the first time in an effort to find a fumigant which was effective against both greenhouse red spider and aphids.

The most promising fumigant was prepared by adding small amounts of the pure gamma isomer of  $C_6H_6Cl_6$  to commercial Fulex paste. Addition of 1.24 percent, 2.48 percent, and 4.96 percent gamma isomer were equally effective and gave complete kill of aphids while retaining the usual high kill of red spider from Fulex.

Pressure fumigation cans containing 17.5 percent azobenzene were very effective against red spider and practical in spite of slight bleaching of pink flowers. The addition of 10 and 16 percent azobenzene to Fulex paste was slightly less injurious than the azobenzene, and effective.

Other materials were discarded for reasons indicated:

Amino azobenzene—effective, but left disastrous yellow residue.

Isopropoxyl diphenyl amino—ineffective.

Vultrol (U. S. Rubber Co.)—ineffective.

Dichloraniline—effective but caused severe plant injury.

$C_{10}H_6Cl_8$  (Velsicol)  $\frac{1}{2}$  ounce—1,000 —ineffective as used.

**Biology and Control of the Celery Plant Bug.** (W. D. Whitcomb and Wm. Garland, Waltham.) The results of the insecticide experiments on the celery plant bug in 1946 show that nearly all of the materials used killed the bugs well and eliminated them from the plants immediately after treatment. From the standpoint of lasting protection, however, the sprays of DDT wettable powder were outstanding and no bugs were found on the count plants in these plots for the remainder of the season.

From a practical standpoint, 1 pound of 50 percent DDT wettable powder in 100 gallons of spray ( $\frac{1}{2}$  pound actual DDT) was as effective as the 2 pound—100 gallon dosage. DDT—talc dusts containing 3 and 1 percent were effective for a month and gave good protection from black heart; but  $\frac{1}{2}$  percent DDT dust apparently requires applications at 10–15 day intervals to give adequate protection. Dry Pyrocid 7 $\frac{1}{2}$  dust is also effective but requires more frequent applications. Special Multicide ( $\frac{1}{2}$  percent DDT and pyrethrum) was the most effective dust used, with 97.94 percent of the plants free from black heart injury, and was very promising under the conditions of the experiment. Applications of this dust at 30-day intervals should be satisfactory. Sabadilla—lime dust 10 percent gave protection for only a few days.

Based on these experiments, practical control of the celery plant bug, *Lygus campestris*, and the resulting black heart injury should be obtained by spraying about August 10 with  $\frac{1}{2}$  pound of DDT (1 pound 50 percent DDT wettable powder) in 100 gallons of water or fungicide, and if necessary following with Dry Pyrocid 7 $\frac{1}{2}$  dust about September 20 when the second generation of the plant bugs is most abundant.

The use of DDT on celery involves a residue tolerance which has been set, at present, by the U. S. Food and Drug Administration at 7 parts per million. Analyses to determine the relation of the effective treatments to the residue tolerance will be made as soon as possible.

**Biology and Control of the Grape Cane Girdler.** (W. D. Whitcomb and Wm. Garland, Waltham.) On unsprayed grape canes, grape cane girdler beetles lived an average of 114.2 days and made 18.8 scars per beetle. Sprays of DDT wettable powder killed the beetles in 2.57 days and reduced the scars to 0.23 per beetle. There was no significant difference in effectiveness of  $\frac{1}{2}$ , 1, 2, 3, or 4 pounds actual DDT per 100 gallons, and DDT was equally effective when combined with basic copper sulfate or Fermate. Benzene hexachloride 50 percent wettable powder containing 6 percent gamma isomer was also effective, at the above dosages, when repeated after 5 days. Lead arsenate was slightly less effective at dosages of 3 or 4 pounds per 100 gallons. The most effective treatments were combinations of DDT, 1 pound actual, with 2 pounds of benzene hexachloride as above, or with 2 pounds of lead arsenate per 100 gallons of water.

In the vineyards, prevention of girdled canes and other injury was more dependent on spraying whenever the canes increased their growth about 6 inches than on the insecticide formula used.



**Sprays to Prevent Scolytid Infestation of Elm Logs.** (W. B. Becker.) At Springfield, a number of sprays including different concentrations of DDT (dichloro-diphenyl-trichloroethane) and DDD (dichloro-diphenyl-dichloroethane) were applied once (May 14 to 16) to the entire bark surface of elm logs before scolytids could attack them in the spring. Each test involved 20 to 31 square feet of bark with a maximum thickness between  $3/8$  and  $7/8$  of an inch. The percentages of prevention were based on the number of exit holes found per square foot of bark in the late fall, compared with those in unsprayed logs. In each instance the quantity of spray applied was what the operator estimated to be necessary to thoroughly wet the surface of the bark (58 to 166 ml. per square foot). *Scolytus multistriatus* Marsham was much more abundant than *Hylurgopinus rufipes* (Eich.) in both sprayed and unsprayed logs.

No. 2 fuel oil alone gave 100 percent prevention, as did also orthodichlorobenzene and No. 2 fuel oil, mixed 1 to 8 by volume. DDT solutions in No. 2 fuel oil, at concentrations between 0.0625 and 5.0 percent actual DDT, gave 99.7 to 100 percent prevention. A 50 percent DDT wettable powder in water gave 74.6 percent prevention at 0.0625 percent DDT, 95.4 percent at 0.125 percent DDT, 97.4 percent at 0.25 percent DDT, and 100 percent prevention in concentrations containing from 0.5 to 5.0 percent DDT. A 25 percent DDT emulsion in water gave 98.5 to 100 percent prevention in all concentrations used, from 0.0625 to 5.0 percent actual DDT. A 25 percent DDD emulsion in water gave 70.6 percent prevention at 0.0625 percent DDD, 95.1 percent at 0.125 percent DDD, 94.8 percent at 0.25 percent DDD, 98.3 percent at 0.5 percent DDD, 99.5 percent at 1.0 percent DDD, and 100 percent at 3.0 and 5.0 percent DDD.

**Sprays to Kill Scolytids Breeding in Elm Logs.** (W. B. Becker.) At Springfield, DDT and DDD sprays at the same concentrations used for the preventive applications were applied once to elm logs in an attempt to control established scolytid infestations. Relatively light applications (between 27 and 53 ml. of spray per square foot of bark) were made on June 11 to recently cut elm logs soon after the scolytids attacked them. Beetle emergence commonly starts about the first of August from such logs. Because of the timing of the applications, the spray residues weathered for the longest period of time which would ordinarily be required in any one growing season. Each test involved 27 to 31 square feet of bark of a maximum thickness of  $5/8$  to 1 inch. In these, as in all other spray applications, the sprayed logs were covered with a single layer of other logs to avoid larval mortality from high subcortical temperatures caused by the rays of the sun.

There was no apparent relationship between the strength of the sprays used and the number of brood galleries constructed in the various sets of logs. Based on the number of empty exit holes per brood gallery in the autumn, the DDT sprays gave no control at the lower concentrations and mostly poor control at the higher concentrations. At 5 percent DDT, the oil solution gave 81.5 percent control, while the wettable powder and emulsion sprays gave approximately 54 percent control. The DDD sprays gave no control.

Best results were obtained with the higher concentrations of DDT in oil solution, possibly because of the presence of the oil, which causes mortality by itself when applied in sufficient quantities; and possibly because the DDT was carried down into the bark by the oil solution and so killed beetles before they could reach the surface. Probably the DDT in water emulsion and especially the

DDT in water suspension remained at the surface of the bark to a greater extent, and so permitted more adults to tunnel out to the surface.

It was interesting to note, however, that as the concentration of DDT and DDD in the sprays was increased, usually a higher percentage of adults was found dead in exit holes in the autumn, a phenomenon which has not been observed to result from the types of sprays tried previously. This suggests that some emerging adults were killed by the DDT and DDD spray material they encountered very close to or at the surface of the bark. No one type of DDT spray proved to be consistently superior, in this respect, to the others at the several concentrations used in these tests.

To what extent DDT caused mortality among the adults which completely emerged from the bark was not determined. It would no doubt be influenced by the amount of DDT residue remaining effective on the surface of the bark when they emerged and by the extent to which the adults crawled around on the bark immediately after emerging. The extent of this crawling may be influenced by the environmental conditions on the surface of a log.

**Preliminary Spraying Experiments to Prevent Twig Feeding by the Smaller European Elm Bark Beetle.** (W. B. Becker.) Feeding on live elm twigs by the smaller European elm bark beetle (*Scolytus multistriatus* Marsham) after it emerges from dead elm bark is at present believed to be one of the more important methods by which the fungus which causes Dutch elm disease, *Ceratosomella ulmi* (Schwarz) Buisman, is introduced into living elm trees. Since twig feeding may occur from spring to autumn, it is desirable that any preventive spray should give protection for as long as possible, to keep the number of spray applications at a minimum. Some of the newer types of spray materials which leave a deposit having a relatively long residual effect were used in attempts to reduce the amount of such twig feeding. Commercially prepared DDT and DDD sprays were used in concentrations between 0.0625 percent (which is slightly less than the strength used to combat defoliating insects on living plants) and 5.0 percent (which is the strength commonly used for some household pests where spray injury to plants is not a problem).

Sprays were applied directly to low branches of living American elms, *Ulmus americana* L., until or almost until the spray began to run off. Three series of applications were made, each on different elms in full foliage, two series in June and one in August. A three-gallon compressed air sprayer was used with a Mohawk adjustable nozzle which gave a cone-shaped spray pattern. Feeding tests were run in the laboratory with freshly cut twigs from sprayed elms placed in gallon size glass jars with newly emerged beetles. Control estimates are based on a comparison between the number of punctures which reached the cambium of sprayed and unsprayed twigs kept in separate jars.

At spray concentrations near those now used for defoliating insects, prevention of *S. multistriatus* twig feeding did not last as long as would seem desirable. As the concentrations were increased, much more lasting protection was obtained, but unfortunately the foliage injury to elms caused by the DDT emulsions increased to an undesirable point, and injury to hard maples and some other plants on which the spray drifted was even greater. While the DDT wettable powders caused no injury worth mentioning, the spray deposit left by the higher dosages was quite noticeable and the nozzle frequently clogged. Mites also caused some very noticeable browning of the sprayed leaves, as other workers with DDT have reported. Such high spray concentrations would cost correspondingly more than the lower strengths commonly used for defoliating insects.

At comparable strengths, the DDT emulsions lasted longer than the DDT wettable powder sprays; and as far as the test went, the DDD emulsions seemed to give results somewhat below those obtained with the DDT wettable powders.

In the early spring of 1947, several commercial DDT emulsion concentrates were applied while the trees were still dormant, at strengths up to 2.0 percent DDT, and no noticeable injury to the elms was observed. The long-term residual effects of these spray deposits are being studied, as is also the possibility of beetles feeding on the new unsprayed twig growth which appears after the dormant spray application.

Future studies may reveal whether laboratory feeding tests such as these approximate what might actually happen in the field where the beetles can move about freely, and to what extent the occurrence of Dutch elm disease will be affected by the reduction of this twig feeding.

**Use of a Mist Blower to Apply Concentrated Sprays to Elms to Prevent Twig Feeding by the Smaller European Elm Bark Beetle.** (W. B. Becker.\*) A new Buffalo turbine blower was used to apply DDT to large elm trees in the forms of concentrated (up to 15 percent) oil solutions and water emulsions. The spray nozzle was altered so two cone-shaped jets of spray were ejected into the high velocity air current in the mouth of the blower. An output of as little as nine gallons of spray per hour could be applied.

Preliminary experiments with this mist blower resulted in relatively long lasting prevention of *S. multistriatus* twig feeding in the lower portions of an elm (20 to 25 feet from the ground) when sufficient spray was directed at the tree. However, in the upper portions of medium-sized elms (60 to 65 feet high) protection was often relatively short, even when one and two gallons of a 12 percent spray were applied to one such elm. When dosages were near those used to combat defoliating insects (approximately one quart of a 12 percent DDT spray), long-term protection against *S. multistriatus* twig feeding was often not satisfactory even on the low branches 20 feet from the ground. Freshly cut twigs from different heights in the elms were tested in gallon size jars as described under the preceding title.

Preliminary experiments with this mist blower point out that for reaching the tops of shade trees best results are obtained when there is no wind movement. Naturally, when using such strong insecticides, even in mist form, one must avoid getting too close to the plants, and also avoid putting on an excess of the spray mist; otherwise plant injury may result.

Experiments are being continued with different types, strengths, and volumes of spray.

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\*The author is indebted to entomologists at the Field Headquarters, Gypsy and Browntail Moth Control, of the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine, at Greenfield, Mass., for much helpful information about mist blowers and their operation.

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## FEED AND FERTILIZER CONTROL SERVICES

John W. Kuzmeski in Charge

The feed, fertilizer and milk testing laws are administered as one service and the operations of each, with the exception of the milk testing law, are reported in annual bulletins.

Under the milk testing law 11,089 pieces of Babcock glassware were calibrated and 191 certificates of proficiency in testing were issued. All milk depots and



milk inspection laboratories in the Commonwealth were visited at least once to check apparatus and general conduct of the work.

In addition to the regulatory work the Feed and Fertilizer Control laboratories have examined feeds, fertilizers and other agricultural materials for citizens of the Commonwealth without charge whenever the results were considered of interest to the general public or to the Control Services.

Considerable work has been done on research projects in cooperation with other departments of the University and Experiment Station. The results of such work are reported by the departments originating the projects.

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## DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

**Breeding Snapdragons for Variety Improvement and Disease Resistance.** (Harold E. White, Waltham.) The variety Helen Tobin and a pink-flowered inbred line P-41 intercrossed yielded progeny that was 90 to 100 percent resistant to rust under field conditions. Hybrid progeny from these crosses was more vigorous than the parent lines and more uniform as to flower colors. The P-41 strain is resistant to rust and transmits this character readily to rust-susceptible varieties when crossed with them.

A number of samples of seed from the Field Station hybrids have been distributed to local growers. Several growers have reported that the hybrids are an improvement over many of the commercial varieties and that cut blooms from them have brought better monetary returns.

Six of the Field Station hybrid lines were tested in California where they did not prove to be resistant to Form 2 of the snapdragon rust, even though they were resistant to Form 1 which is prevalent in Waltham.

Strains of snapdragon from Waller Franklin Seed Company, Guadalupe, California, were tested at Waltham and found to be highly resistant to the form of rust present here. However, they are not as free flowering as the Field Station strains.

**Subirrigation Methods of Watering Carnations.** (Harold E. White, Waltham.) Three different systems of applying water to subirrigated benches were studied: constant water level with regulation by a float valve, manual injection, and automatic injection.

The automatic injection method was of two types, whereby (1) a solenoid valve was operated through a relay and time clock, and (2) a solenoid valve was controlled through a pneumatic and a pressuretrol control regulated by means of a stoker timer. This pneumatic system was connected to an air pressure thermostatic control unit used to operate the greenhouse heating system. Soils were watered by manual and automatic injection systems when between 2 and 3 pounds vacuum pull in the soil showed on the tensiometer vacuum gauge.

Investigation of the pneumatic system of automatic water injection is being conducted through cooperation with the Minneapolis-Honeywell Regulator Company, Minneapolis, Minnesota.

Varieties of carnations used in the tests were: Weld, Northland, Tom Knipe, Hercules, Salmon Virginia, and Dark Pink Virginia. The soil, which had been used for carnations the previous year, was sterilized with steam.

Carnation plants made equally good growth under all three methods of watering. Flower production on the differently watered benches did not vary significantly. Splitting of the blooms was not noticeably affected by the different methods of watering. The plants grew and produced equally well in ground concrete beds and in raised concrete benches.

Roots of carnation plants grown under subirrigation methods do not penetrate the gravel layer beneath the soil to any great degree. Examination of plants carefully removed from such benches showed that the roots mat in a layer at the junction of soil and gravel level, closely comparable to the condition that occurs with roots of plants grown in clay pots.

Observations of top-watered benches in commercial ranges where carnations are grown show that, in comparison with subirrigation methods of watering, carnation plants are in greater danger of being inadequately supplied with water rather than of being over-watered, as most growers fear. This is particularly true during summer months, early fall, and spring.

Losses of plants from stem, root, or branch rots were not observed to be any more prevalent under constant water level methods than in manual or automatic injection systems of watering.

**Sodium Selenate as a Red Spider Control.** (Harold E. White, Waltham.) The use of sodium selenate for red spider control by commercial flower growers in the State continues to increase. This past year between 40,000 and 50,000 pounds of P-40 were used by carnation and chrysanthemum growers in Massachusetts. The P-40 is granular superphosphate impregnated with 2 percent of sodium selenate and is the popular form used since it can be applied to bench soils as readily as fertilizer. Growers of bench crops have shown greater interest in sodium selenate than growers of pot plants.

A few growers of hardy chrysanthemums have tried sodium selenate for control of foliar nematode, a disease that has become more common in hardy chrysanthemum plantings outdoors.

Experiments so far at Waltham have been confined to the use of sodium selenate as a method of insect pest control from the viewpoint of commercial application. From these tests certain information has been derived, and problems have arisen that indicate a need for more detailed investigations.

**Rooting of Carnation Cuttings in Subirrigated Sand and Vermiculite.** (Harold E. White, Waltham.) Cuttings of ten varieties of carnations were used for rooting tests in Vermiculite (mica), subirrigated and top-watered, and in sand, subirrigated and top-watered. The  $\frac{1}{4}$ -inch and  $\frac{1}{2}$ -inch grades of Vermiculite were compared as rooting media, as were mixtures of sand and Vermiculite; but appreciable differences were not distinguished in the use of the two sizes of Vermiculite.

When root formation on cuttings rooted under the different treatments is evaluated in terms of excellent to good, the ratings in percentage of rooting are as follows: sand subirrigated 71; sand top-watered 75; Vermiculite subirrigated 72; and Vermiculite top-watered 83.

When all the rooted cuttings of a treatment are grouped together without classification, the results are: sand subirrigated 77 percent; sand top-watered 90 percent; Vermiculite subirrigated 81 percent; and Vermiculite top-watered 90 percent rooted.

The results of these tests show that a mixture of sand and Vermiculite when top-watered produced a higher percentage of rooted cuttings than similar media

subirrigated. However, even though sand top-watered was comparable to Vermiculite in percentage of cuttings rooted, the roots formed in the Vermiculite were 50 percent greater in length and more numerous on individual cuttings. Initiation of roots on cuttings in the Vermiculite does not appear to occur sooner than in sand, but roots grow much more rapidly once they are formed. This striking difference in rate of growth between roots produced in the two media probably is due to a more uniform supply of available moisture to the roots in Vermiculite. Also, there is better aeration due to less tendency of the Vermiculite to pack.

Since cuttings transplanted from a rooting medium such as Vermiculite have roots with thinner cellular tissue, the soil into which the roots are placed must be kept more moist until they have become established in it.

**Dusting China Asters with Insecticides for Control of Yellows.** (Harold E. White, Waltham.) During the summers of 1945 and 1946 various kinds of insecticidal dusts were applied to China Asters under field conditions to determine the effectiveness of such treatments in control of leafhoppers which carry the yellows disease.

In 1945, test plots were dusted at 7 to 10 day intervals with a 2½ percent DDT-sulfur dust and a 5 percent DDT-sulfur dust. Two formulations of each of these dusts were used, one being a fused DDT-sulfur and the other a mechanical mixture of DDT-sulfur.

The treatments in 1946 were along similar lines with 1 percent DDT, 3 percent DDT, sabadilla 10 percent, pyrethrum dusts, and a formulation known as X 155 which contained 12 percent nicotine and 7 percent DDT.

Tests made with these different insecticidal materials on living leafhoppers confined in a cage showed them to be toxic to the insects. However, the field tests made by dusting China Aster plants in the open yielded no significant data insofar as reduction of the yellows disease was concerned. Apparently these dusts, as used under field conditions, were not sufficiently repellent to prevent leafhoppers from feeding on plants and transmitting the yellows virus.

From these tests, it would seem that insecticides applied to asters in order to control yellows must be of a highly repellent nature to keep the leafhoppers from the plants.

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## DEPARTMENT OF FOOD TECHNOLOGY

C. R. Fellers in Charge

**Incidence of Home Canning Spoilage Bacteria in the Soil.** (W. B. Esselen, Jr., G. K. Lycarzyk, and C. R. Fellers.) During the summer of 1945, 325 samples of soil and raw vegetables were obtained from 15 gardens of Amherst and vicinity; and in 1946, 671 samples were collected from 12 gardens of the same locality. The samples were examined bacteriologically in order to study the incidence and factors influencing the incidence of thermophiles, putrefactive anaerobes, and flat sour organisms, these being representative of important groups of spoilage bacteria encountered in home canning.

These three groups of bacteria showed considerable variation in numbers during the season. Rainy weather seemed to favor their development. In general, the number of thermophiles present in the soil samples greatly exceeded the numbers of putrefactive anaerobes and flat sour organisms. Gardens treated



with fertilizers of various kinds tended to show higher counts of the organisms studied than did untreated gardens.

**Stability of Riboflavin in Processed Foods.** (W. B. Esselen, Jr., J. E. W. McConnell, and J. P. Crummins.) Studies of factors which influence the stability of riboflavin in canned foods, packed in glass or metal containers, have been continued. Experimental packs of green beans and of synthetic solutions of riboflavin in cans and glass jars were prepared so that the effects of acidity, added iron, tin, ascorbic acid, sodium bisulfite, and sodium dichromate could be observed. Changes in the riboflavin content of these different packs during storage were determined. The results to date are all in general agreement and indicate that the stability of riboflavin in processed foods may be influenced to some extent by the relationship of oxidizing and reducing conditions present in the product and container. The presence of a relatively small proportion of ascorbic acid or tin (stannous chloride) tended to cause a greater loss of riboflavin during storage than occurred in control samples; but when the proportion of ascorbic acid or tin was increased, it tended to reduce the loss of riboflavin, particularly in an acid medium. The addition of iron (10 and 100 p.p.m. of ferrous chloride) to glass-packed green beans and synthetic riboflavin solutions had little or no effect on the stability of riboflavin.

**The Use of Calcium Chloride to Maintain Firmness in Canned and Frozen Apples.** (W. B. Esselen, Jr., and W. J. Hart, Jr.) The effectiveness of treatment with calcium chloride in retaining the firmness of canned and frozen sliced McIntosh and other varieties of apples has been reaffirmed. September through December were found to be the best months for freezing McIntosh apples. When held in cold storage for longer periods, this variety reached a point where the use of calcium chloride was no longer effective in maintaining firmness.

After the apples are peeled, cored, and sliced, the slices may be readily treated by dipping them in a dilute solution of calcium chloride (U.S.P. grade). The strength of the solution required will depend upon the variety and condition of the apples, the time of dipping, and the ultimate degree of firmness desired. Under most conditions a five-minute dip in a 0.1 percent calcium chloride solution was found to yield a very satisfactory product. In many cases the calcium treatment can be combined with the treatment used to prevent darkening.

Calcium chloride was found to be effective as a firming agent for fifty varieties of apples when they were canned or frozen. With apples that were quite firm initially, there was no advantage in using the calcium treatment, and in some cases the treated slices may be objectionably firm and rubbery.

Laboratory and commercial tests have indicated that sliced McIntosh and Wealthy apples may take up calcium in amounts ranging from .019 to .054 percent calculated as anhydrous calcium chloride, with average values of .030 to .045 percent. While there has been no official ruling on the use of calcium salts for firming apple slices, it may be noted that under the Federal Food and Drug Administration Regulations it is permissible to add up to 0.07 percent of calcium chloride to canned tomatoes to aid in maintaining their firmness.

**Home Freezing.** (W. B. Esselen, Jr., J. E. W. McConnell, N. Glazier, and C. R. Fellers.) A bulletin on home freezing has been prepared and printed. It is based on work carried on here and by other agencies and contains information on such phases of home freezing as economics, comparison with home canning, freezer operation, varieties of fruits and vegetables for freezing, technics, and a discussion of the importance of home freezing in Massachusetts.

Work was continued on the quality of different varieties of fruits grown in this area when frozen by home-freezing methods. Samples of fruits were provided through the cooperation of the Department of Pomology. The products frozen during the 1946 season included 11 varieties of strawberries, 4 of raspberries, 15 of plums, 2 of currants, 9 of cultivated berries, and 26 of peaches. This variety investigation is being continued during 1947 in order to obtain additional information over a period of several seasons.

The addition of small amounts of ascorbic acid to home-frozen peaches was effective in improving the color and flavor of the finished product.

In the course of other investigations, during the past five years, approximately 10,000 jars of fruits, fruit juices, vegetables, meats, fish, and poultry have been frozen under typical home-freezing conditions. Glass containers are satisfactory for home freezing as they provide a moisture-proof container which can be re-used many times. No trouble from breakage has been encountered. The chief objection to glass jars is that inherent in all round containers; they waste space in the freezer, as compared with square-sided containers. This disadvantage would probably be offset by the advantages in many cases.

**Nutritive Value of Cultivated Mushrooms.** (C. R. Fellers, J. E. W. McConnell, and W. B. Esselen, Jr.) A five-year investigation of the nutritive value of cultivated mushrooms (*Agaricus campestris*) has been completed and the results summarized in Experiment Station Bulletin 434 which was published last summer. Data were obtained on the proximate composition; protein, carbohydrate, and vitamin content; and the effect of cooking, canning, dehydrating, and freezing on their "B-vitamin" content. Mushrooms were found to be excellent sources of certain of the B vitamins, such as riboflavin and nicotinic acid. They also contain approximately 2.6 percent of protein and all of the essential amino acids, at least in small amounts.

**Jar Rings for Home Canning.** (W. B. Esselen, Jr.) An investigation of factors which influence the quality of jar rings for use in home canning, initiated in 1943 in cooperation with the jar ring industry, the Department of Agriculture, and other Government agencies, is being continued. Tests completed in August 1946 indicated that the use of natural rubber in place of synthetic rubber (both in combination with reclaimed rubber) did not necessarily produce jar rings which were free from off-flavors. It has been shown that reclaimed rubber and certain chemical accelerators and antioxidants used in jar rings may be important causes of off-flavors. Tests are in progress now on jar rings made entirely of natural rubber and of a combination of natural and synthetic rubber.

**Processing Methods for Home Canned Fruits.** (Cooperative Project with the Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture.) (W. B. Esselen, Jr., A. C. Avery, and J. E. W. McConnell.) Additional heat penetration data have been obtained on home-canned rhubarb, strawberries, sliced apples, blueberries, peaches, tomatoes, and plums. Tests were made on both pint and quart jars filled at temperatures of 80°, 140°, and 175° F. The jars were processed until internal "cold point" temperatures of 155°, 175°, 185°, and 200° had been reached. The process times thus determined averaged a little less than those recommended in most home-canning instructions. From observations and data obtained on recommended home-canning procedures for fruit, it was evident that such variable factors as intensity of heat source, variety and maturity of the fruit, and temperature and circulation of cooling air may have

a decided effect on the required process times. Allowances should be made in prescribed process times to cover these variations.

**Glass-Packed Citrus Juices.** (W. B. Esselen, Jr., J. E. W. McConnell, and C. R. Fellers.) Further storage tests at 35°, 50°-60°, and 70°-85° F. (room temperature), on commercially packed grapefruit juice, orange juice, and a blend of grapefruit and orange juice, in cans and in glass containers, substantiated previous observations that the ascorbic acid content is well retained after storage for one year. Juices stored at 35° and at 50°-60° for one year showed no significant change in color and flavor, while samples stored at room temperature (70°-80°) retained their original quality for six months but after that showed a marked deterioration in flavor. At room temperature the color of the glass-packed orange juice stood up quite well, but the grapefruit juice and the grapefruit-orange juice blend packed in glass containers darkened considerably after six months. From the experimental results it appears that it should be possible to place good-quality glass-packed citrus juices on the market if warehouse temperatures are maintained at 50°-60° F. or lower. Cold storage at temperatures of 35°-40° F. is not necessary.

**Prevention of Darkening and Deterioration in Flavor of Citrus Juices.** (J. E. W. McConnell, W. B. Esselen, Jr., C. MacCormack, A. Kaplan, and C. R. Fellers.) The addition of ascorbic acid or the storage in an inverted position of bottles sealed with plain tin coated caps favored color retention in citrus juices. The combination of both factors produced more favorable results than either alone.

Added tin in the form of stannous ions had a stabilizing effect on the color of bottled orange juice. The optimum concentration of stannous ions, as determined by accelerated storage tests, was between 100 and 200 p.p.m. Small amounts of iron (above 8 p.p.m.) accelerated darkening of the juice.

The value of various substances as antioxidants for orange juice was investigated by adding them to the juice at 0.1 percent concentration and submitting the bottled, pasteurized juice to an accelerated storage test at 125° F. Among the substances tested were *p* hydroxydiphenyl, *p* aminoacetophenone, *b*-hydroxy quinoline, orcinol, catechol, caffeic acid, glycine, ethyl and propyl gallate, and a series of quinones having oxidation-reduction potentials between +0.131 and +0.656 volts. The gallates and sodium 2,7 anthraquinonedisulfonate (oxidation-reduction potential +0.242) were the only substances tested which protected the orange juice against flavor deterioration; however, they had little or no effect on the color.

**Color Measurement of Citrus Juices by Means of a Photoelectric Reflection Meter.** (W. B. Esselen, Jr., M. Paparella, J. E. W. McConnell, and C. R. Fellers.) Determination of the amount of light reflected by citrus juices by means of a photoelectric reflection meter was found to provide a rapid and accurate index of the color of the juices and a good method for following color changes in the juices during storage. Correlation with visual grading was as good as or better than the correlation between visual grading and light transmission values determined on the filtered juices. This method of color determination should be especially useful in following surface discoloration.

A white reference standard may be used, but maximum sensitivity may be obtained by using a colored reference standard similar to the color of the product being examined. In following color changes of foods during storage, the band



of light giving the best correlation with visual color changes and the maximum sensitivity must be determined for each product.

**Process Times for Glass-Packed Foods.** (J. E. W. McConnell and W. B. Esselen, Jr.) A cooperative project with the Glass Container Manufacturers Institute, the National Canners Association (Washington, D. C., and San Francisco, Calif., laboratories), and the California State Department of Health was undertaken to compare the heating rates and sterilizing values obtained with comparable sizes of glass containers and cans under different retort and processing conditions.

Bentonite suspensions (1 and 5 percent) were used to simulate convection and conduction heating products, respectively, as this offered a stable medium which could be duplicated and used several times in succession. The third type of food product, that exhibiting a "broken curve," could not be satisfactorily represented by a bentonite suspension because the heating characteristics varied with successive runs. Investigation of bentonite suspensions which produce a "broken curve" revealed that the rate of heating has a marked effect on the type of curve obtained. Rapid heating, with its accompanying greater convection currents until close to retort temperature, when the rate of heating and convection currents markedly slow down and permit the suspension to change from a sol to a gel state, is essential in obtaining a good broken curve.

It was concluded that the longer come-up time used in glass processing and home canning can markedly affect the type of heating curve between cans and glass containers to influence this type of broken curve obtained.

**The Stability of Carotene and Vitamin A in Mixed Rations and the Comparative Efficiency of These Components for Egg Production and Growth.** (Cooperative project with Department of Poultry Husbandry. L. R. Parkinson and C. R. Fellers.) Controlled levels of carotene (derived from alfalfa) and vitamin A (from fish liver oils) were added to broiler rations at the start of the experiments. Periodic determinations indicated that carotene was destroyed more rapidly than vitamin A during the first two weeks of storage; but after two weeks the vitamin A decreased at a more rapid rate. At the end of 8 weeks 61.5 percent of the vitamin A remained, whereas at the 12-week interval only 37 percent of the original amount was left. The broiler ration containing the largest amount of carotene lost 36 percent of its carotene in the first 2 weeks, but at the end of 12 weeks 49 percent of the original amount still remained. The ration containing the smaller amount of carotene showed a loss of 36 percent during the first 2 weeks, but thereafter the rate of destruction was less, and at the end of 12 weeks 62.5 percent of the original amount still remained.

Superior feathering of broilers was obtained in this experiment by feeding vitamin A in the form of a carotene extract from alfalfa.

No deficiencies in fleshing were noted regardless of whether carotene from alfalfa or natural vitamin A was fed at equivalent levels.

Normal egg production was obtained at a level of 3000 International Units of vitamin A per pound of feed, whether this was natural A or carotene extract from alfalfa. There was little difference in egg production at the feeding level of 1000 International Units of natural vitamin A per pound of feed. There seems to be no advantage in feeding three times this amount for egg production alone; but to obtain good strong, healthy chicks, a higher level of vitamin A is indicated by the hatchability and viability data.

**Red Squill Toxicity Studies.** (L. R. Parkinson and C. R. Fellers.) In previous work in this department, it was found that the toxic properties of raw red squill were extremely variable. Many of the squills being shipped to this country were of such inferior toxicity that their use in rat control operations was impractical. The possibilities of extracting the toxic principle from these low-quality squills were investigated with the idea of making them suitable for successful rat control. A direct result of this work was the appearance of several methods of fortifying these relatively poor quality squills.

During the past year several samples of raw red squill, originating from the Mediterranean area, were tested for their toxic effect on rats. The majority of these proved to be of poor toxic value. These findings prevented the distribution to the general public of a considerable amount of poor red squill. The processors of this material will subject it to a fortification process, thereby making a highly acceptable poison for rats.

**Preservation of Pheasant Meat by Canning, Freezing, and Smoking.** (C. R. Fellers, E. E. Anderson, and H. U. Goodell.) In cooperation with R. E. Trip-pensee of the Wildlife Department, experimental packs of pheasant, which were canned in glass, frozen, or smoked, proved to be highly satisfactory in palatability and appearance. In general, only slight revisions of the procedures normally employed for the handling of chicken were required.

**The Composition and Nature of Apple Protein.** (S. G. Davis and C. R. Fellers.) Despite the widespread use of apples in food and food products, and the numerous chemical and nutritional studies to which the fruit has been subjected, little attention has been given to the amount and composition of apple protein. The scarcity of such data may well be explained by the fact that the protein content of the apple, in common with that of most fruits, has not been considered nutritionally significant. Estimated on the basis of the alcohol-insoluble nitrogen fraction, the protein of the apple flesh (exclusive of skin and seeds) per 16 grams of nitrogen is around 0.15 percent, alcohol-insoluble nitrogen representing approximately 50 percent of the total nitrogen of samples tested.

Significant amounts of an apple protein fraction can be removed from samples of frozen tissue, thawed, and finally macerated in an alkaline buffer solution, by means of a flotation method whereby the protein is dispersed and collected in a foam. The material as collected and dried has a nitrogen content of approximately 10 percent without purification.

Amino-acid determinations, performed on both dried apple flesh and protein extracts by microbiological methods, indicate the presence of the indispensable amino acids, with the exception of tryptophane, in proportions similar to those of most common proteins.

Work is continuing on the non-indispensable amino acids and the characterization of the protein system.

**The Viability of Dried Bakers Yeast.** (R. E. Morse and C. R. Fellers.) A study is under way to determine the factors which influence the viability of dried yeast. There are two major phases of the work: the factors which exert their influence during the production of the yeast, and those which are exerted during storage of the finished product.

To study the important phases of yeast production, a laboratory-scale replica of a yeast-producing plant has been set up. Here the steps used in commercial production of yeast are duplicated. The steps that are being observed for their

influence on the viability of the final product are the seed yeast, the nutritive factors during yeast production, and the method of drying, including temperature and time.

The storage factors were studied after a suitable fermentmeter had been constructed which permitted the recording of gas pressure produced by a mixture of yeast, flour, and water. Dried yeast was then packed in various gas atmospheres such as carbon dioxide, nitrogen, oxygen, and air; and stored at various temperatures, including  $-5^{\circ}$ ,  $40^{\circ}$ ,  $70^{\circ}$ , and  $100^{\circ}\text{F}$ . Various containers were also used, in order to determine the effect of light during storage. Temperature appears to be the most important factor of all. In 18 days, dried yeast stored at  $100^{\circ}\text{F}$ . was no longer suitable for baking bread, regardless of the container or the gas atmosphere used.

**Vitamin D Bioassay Research.** (C. R. Fellers and L. R. Parkinson.) As yet, no physical or chemical methods have been devised that are accurate for the determination of vitamin D in food. A literature survey has been made of likely procedures, and research will be carried out to check new laboratory methods against the standard rat bioassay. An enormous saving of time and cost will result if chemical or physical procedures can be perfected.

Of the 72 samples of vitamin D milk assayed during the year, two were seriously deficient and three slightly deficient in vitamin D.

**Fish Investigations.** (C. R. Fellers and A. Lopez-Matas.) Studies on fresh, frozen, canned, and smoked swordfish have been completed, and three scientific papers prepared for publication. The study covers both technological and nutritional aspects.

**Rapid Estimation of Added Aluminum in Foods.** (C. R. Fellers and R. Barton.) A nephelometric method has been perfected which is accurate for inorganic aluminum to  $\pm 10$  parts per million. The brine or pickle is cleared with phosphotungstic acid, the pH adjusted, and the aluminum hydroxide precipitated with ammonia. The density of the suspended aluminum hydroxide is read in a specially constructed nephelometer. A description of the procedure is being prepared for publication.

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## DEPARTMENT OF HOME ECONOMICS NUTRITION

Julia O. Holmes in Charge

**Losses of Iron in the Menses of Women.** (A. W. Wertz, B. V. McKey, and J. O. Holmes.) Because of the loss of blood in the menses it is customary to recommend a higher level of iron for women than for men. As a part of the study on the metabolism of iron in women, conducted last year, a collection was made of the menses throughout the 115-day experimental period. Because of its significance in determining the requirement of iron by women the results of the analyses of the material are presented here. The losses of iron by these four women varied markedly, although the loss of an individual woman was fairly constant from period to period. The subjects ranged in age from 24 to 37 years; none had had any children. The range in iron excreted per menstrual period was as follows: Subject A, age 28 years, 1.98-2.49 mg.; Subject B, age 29 years, 2.6-8.13 mg.; Subject C, age 24 years, 15.13-33.9 mg.; Subject D, age 37 years,



8.04–10.98 mg. There appears to be no correlation between the age of the subject and the amount of iron excreted per period. From the limited data presented here, it appears evident that there is a wide range in the amount of dietary iron needed by different women to offset the loss of iron in the menses. For example, Subject C, losing an average of 25 mg. of iron per menstrual period and being able to utilize about one-third of her dietary iron (1946 Exp. Sta. Ann. Rept.), would probably need about 3 mg. of iron in the daily diet to offset this loss. On the other hand, Subject A, losing an average of about 2 mg. of iron per period and being able to utilize about one-third of her dietary iron (1946 Exp. Sta. Ann. Rept.), would need only 0.5 mg. iron in her daily diet to offset this loss.

**Iron Content of Milk.** (A. W. Wertz, B. V. McKey, and J. O. Holmes.) Although it has long been appreciated that milk is a poor source of iron, the values in the literature range from 0.114 to 1.4 mg. per liter. Over a period of 115 days, milk was obtained from the Dairy Industry Department of the University and analyzed for iron. Six quarts were obtained daily and well mixed; aliquots from the mixture were taken and pooled for five consecutive days. Iron determinations were made on 23 pooled samples. The organic matter in the milk was destroyed by wet ashing with nitric and sulfuric acids. O-phenanthroline was the color reagent used for formation of the colored complex, the intensity of which was measured in a Beckmann spectrophotometer. The amount of iron present was calculated from a calibration curve. Because of the large amount of calcium present in the milk, a heavy white precipitate was formed after digestion which necessitated filtering. In order to determine whether any iron was lost throughout the procedure because of the formation of insoluble iron salts, etc., the following procedure was used for several determinations as a check on the method. Six 100 ml. aliquots of milk were measured into 500 ml. erlenmeyer flasks. To three of the flasks containing milk a known quantity of iron was added. The contents of these six flasks, 3 control flasks containing only the standard iron solution and 3 control flasks containing only the reagents used, were carried through the entire procedures of evaporation, digestion, filtration, development of color, and measurement in the spectrophotometer. The data obtained on 8 different series show that recovery of the added iron was 100.05 percent. These results indicate that the wet digestion method of ashing and the use of O-phenanthroline as the color reagent is suitable for the determination of iron in milk. The average value for 23 samples of milk covering a period from January through May was 0.30 mg. iron per liter with a range from 0.25 to 0.38 mg. per liter. The lowest values—0.25–0.29 mg. per liter, were consistently obtained during March and April.

**The Excretion of Iron by the Kidney.** (B. V. McKey, D. C. Staples, J. O. Holmes, and A. W. Wertz.) It has long been known that the quantity of iron in the kidney secretion is small. At the time when the study on iron utilization by women was being planned, the question arose as to whether or not the urinary iron had to be determined. This question was of great importance not only for its significance in the experiment, but also from the standpoint of the work involved in the determination. Therefore, a survey of the studies reported in the literature since 1880 was made. The range in the urinary iron values reported by various laboratories was found to be great; e.g., some workers reported urinary excretions as high as 1 mg. iron per day and one laboratory reported iron excretion by one individual which ranged from 0.01 to 1.93 mg. per day and averaged 0.24 mg. These high values, as well as the great variability in values, indicated

that a careful study of urinary iron would be expedient, particularly since a diet very low in iron was to be fed. During the first 50 days of the experiment when the subjects ate 3.75 mg. iron daily, the daily iron content of the urine for subjects B, D, E, and G was  $0.041 \pm 0.011$ ,  $0.045 \pm 0.012$ ,  $0.059 \pm 0.019$  and  $0.062 \pm 0.019$  mg. respectively. In terms of percentage of the quantity of iron eaten these values for urinary iron represent only 1.1, 1.2, 1.6 and 1.6 percent. During a subsequent 35-day period in which the iron intake was increased to 5.8 mg. daily, the urinary excretion of iron did not rise; on a percentage basis, the values were, therefore, lower; namely, 0.6, 0.6, 0.4 and 0.9 percent. No correlation was found between the daily volume of urine excreted and the daily urinary iron. From the data obtained, it is evident that even on extremely low dietary levels of iron, it is not necessary to determine the iron content of the urine.

**Tooth Decay Studies: Sucrose, Glucose and Lactose as Cariogenic Agents.** (Julia O. Holmes, L. R. Parkinson, Lois Brow, and Anne W. Wertz.) As a result of last year's findings that dental caries could be induced in the *Norwegian* albino rat by feeding sugar as the sole source of carbohydrate in an adequate diet, this year other types of sugars have been fed. The sugars selected were those that form the major portion of man's sugar consumption: namely, sucrose as found in cane and beet sugar, dextrose which occurs in fruits and corn syrup, and lactose, the sugar of milk. These sugars were fed to numerous groups of rats over a period of two years as the only source of carbohydrate in "synthetic" diets which contained all *known* nutrients. Although the rats grew well and were in good health, they developed tooth decay, irrespective of the type of sugar fed. These results showing the cariogenic properties of sucrose and glucose are in accord with the findings of the Wisconsin investigators who have reported that the *cotton* rat will develop tooth decay if fed excessive amounts of fermentable carbohydrates. The National Health Institute reported in 1945 that they had induced caries in about 30 percent of one group of *Norwegian* rats fed sucrose; but that in subsequent groups fed glucose or sucrose, either commercial or confectioners grade, caries did not occur. In respect to lactose, no other report has been found in the literature indicating that it, too, is a cariogenic agent. Since lactose does not undergo fermentation as do the other mono- and di-saccharides, it is obvious that the tooth decay-inducing properties of a sugar are not dependent upon the fermentability of that sugar. It is also obvious that if milk contains some substance which protects against tooth decay, as has been reported by the Wisconsin investigators, that substance is not the milk sugar, lactose.

**Tooth Decay Studies: Excessive Use of Sugars Not Sole Cause of Tooth Decay.** (Julia O. Holmes, L. R. Parkinson, and Lois Brow.) Although the feeding of sugars to rats as their sole source of carbohydrate has resulted in the early development of tooth decay, tooth decay has been experimentally produced this year in rats that had never been fed sugar. The finding that other types of carbohydrates as well as glucose and sucrose would permit the development of tooth decay, is in direct contradiction to the results of other investigators who have asserted that caries does not develop in diets in which sugar is replaced by starch or dextrin. The first indication that a sugar-free diet is conducive to tooth decay came as a result of an attempt to construct a "synthetic" diet which would have some of the essential features of the "corn-meal" diet used by many laboratories for the development of caries in animals. Since the corn-meal diet is notable for its high content of raw starch and its relatively low content of protein, a diet containing starch as its sole carbohydrate and 15 percent of the milk protein, casein,

was constructed. It contained all the *known* ingredients necessary for good growth. The observation that some of the rats fed this ration had cavities on the grinding surfaces of their teeth came as a distinct surprise. As a result of these findings many rats have been reared on diets containing raw or cooked corn starch as their sole source of carbohydrate. Caries has been found in all groups fed such rations. Experiments are now in progress to determine the conditions under which tooth decay will result in the presence of starch. It is felt that research on diets containing raw or cooked starches provides a promising line of investigation since few human beings consume diets in which the major portion of their carbohydrate is sugar.

**Tooth Decay Studies: Raw Corn Contains a Caries-Inducing Factor.** (Julia O. Holmes, L. R. Parkinson, Anne Wertz, and Lois Brow.) A "corn-meal" diet is used in most laboratories today to produce tooth decay in experimental animals. This diet is composed of 66 parts of coarsely ground whole corn, 30 of whole-milk powder, 3 of dried alfalfa meal, and 1 of pure table salt. Since this diet is notorious for the rampant caries it produces, it was decided to feed various fractions of corn to determine whether or not a fraction could be found which had cariogenic properties. The corn fractions were obtained from the Corn Products Refining Company, Argo, Illinois. They included a crude corn oil obtained from the corn germ; corn steepwater, which contained the major part of the water-soluble minerals and vitamins of the kernel; zein, one of the corn proteins; and a gluten fraction which contained, in addition to the corn gluten, zein and some of the corn xanthophylls, and which assayed about 50 percent protein. To the basal ration into which these fractions were incorporated, corn starch and 15 percent casein were added as the sole carbohydrate and protein. The rations were ground to the fineness of flour. The rats receiving corn steepwater developed no more tooth decay than did their brothers and sisters receiving the basal diet only. In contrast those receiving gluten, zein, and crude corn oil had twice as many sites of decay as did their controls on the basal diet. This is the first demonstration of the presence, in a food, of an agent which accelerates the decay of teeth. The findings suggest that, if sugar is a cariogenic agent, it may be only one of many. One of the plans for the immediate future is to determine the nature of the cariogenic factor in corn.

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## DEPARTMENT OF HORTICULTURE

R. A. Van Meter in Charge

**Control of Weeds in the Nursery by Chemical Sprays.** (C. H. Gilgut, Walham.) Of the chemical weed killers in common use at present, the industrial solvent Savasol No. 5 shows most promise for control of weeds in the nursery. It was extensively tested in 1946 in the Field Station nursery and in nearby commercial nurseries. As a result, a number of the more progressive nurseries are using this weedicide in their weed control program. The oil is used undiluted.

So far, the best method of applying the oil is with a hand operated tank sprayer equipped with a nozzle that gives a flat fan-shaped spray. This gives good control of the spray and permits wetting weeds close to a plant without wetting the plant enough to injure it.



Spraying small weeds is more effective and cheaper than spraying large weeds. The small weeds are killed more quickly; there is less risk of injury to the plants since the spray is kept close to the ground; less material is used; and it takes less time to spray a given area.

Late fall spraying of grass weeds which winter over reduces the number of such weeds in the spring.

To the list of narrow-leaved evergreens which are highly tolerant can be added mugho pine. Less tolerant is the Greek juniper, *Juniperus excelsa stricta*.

**Study of Herbaceous Perennial Material.** (C. J. Gilgut, Waltham.) Fifty varieties of plants in the perennial test gardens did not survive the winter. Of these, sixteen were so-called "hardy chrysanthemums," and it is increasingly evident that most chrysanthemums are not reliably hardy here when not protected by mulch or wintered in a cold frame.

Few replacements have been made and no new plants acquired because the gardens are to be moved to another location to make way for the new laboratory and administration building. The preparation of the new location—clearing, grading, laying out of beds, and seeding of walks—is slowly being finished and it is hoped that by fall many of the plants will have been moved in from the old garden.

The collection of American and English hybrid delphinium—among them Gold Medal Hybrids, the color series of Giant Pacific hybrids, Wrexham hybrids, and Blackmore and Langdon hybrids—made good growth and an excellent display in the spring. The Giant Pacific hybrids were awarded the L. H. Leonian Memorial Cup for excellence by the American Delphinium Society, and a cultural certificate and silver medal by the Massachusetts Horticultural Society.

The phlox collection of varieties in commerce is not yet complete, but it is apparent that some are not true to name and several are being sold under different names.

**Factors influencing the Rapidity of Growth of Nursery Stock.** (C. J. Gilgut, Waltham.)

*Rhododendron Leaf Bud Cuttings.* Leaf bud cuttings of 30 named varieties of hybrid rhododendrons taken in November, and again in February, treated with the more common root-inducing substances in liquid and powder form, and placed in various propagating media in the greenhouse failed to root. A few were still alive in June.

*Effect of pH and Nitrogen, Phosphorus, and Potash on Growth of Yews.* It is a common belief among some nurserymen that yews grow better at a pH above 5.8. When the pH of unfertilized field soil was adjusted at pH 4.5, 5.0, and 7.0, there was no appreciable difference in the growth of rooted cuttings of *Taxus media hicksi* and *Taxus cuspidata nana* during the first season.

These varieties grew equally well in unfertilized field soil and in field soil treated so that (1) the nitrogen, the phosphorus, or the potash was high; (2) the nitrogen and phosphorus, the nitrogen and potash, or the phosphorus and potash were high or (3) the nitrogen, phosphorus, and potash were high.

## DEPARTMENT OF OLERICULTURE

G. B. Snyder in Charge

**Asparagus Investigations.** (Robert E. Young, Waltham.) The second generation asparagus planting has been cut now for seven full years and has about reached the half-way point of economic production. The third cutting season produced the greatest yield. The yield for 1945 was only 51 percent of this 1942 yield, and the 1946 crop although greatly improved was still only 71 percent of the highest yield.

An examination of the yield data indicates a decided tendency toward biennial bearing not unlike that found in apples. While only seven years records are available for study, there always have been alternate high and low yields; never two successive increases or decreases. Attempts to correlate this rise and fall of yields with rainfall have been unsuccessful, and there is only a slight relationship to spring temperatures. As might be expected the highest producing strains show the greatest variation in yield from season to season.

This second generation of plants has spread out so far in the rows that it is no longer possible to obtain accurate individual plant records as previously. Of the plants whose accumulative yield places them in the top 50 (12 percent), only four have been in this category all seven years. This also demonstrates the extreme variation in production of asparagus plants. The male asparagus plant is considered the better producer and 72 percent of the plants in the top 50 are males.

In 1942 plants which had started to produce high yields were chosen as parents for the third generation. It is interesting to note that of ten so chosen nine remain in the top 50. A study of the yield records shows that very few plants which produced well at the start have dropped, while there are some which started poorly that are now yielding well.

The highest yielding plant in the experiment is No. 4-79 which produced an average of 2.6 pounds of asparagus per year as compared to the annual average of 0.88 pounds per year for all the plants.

To determine whether the high yielding plants can transmit this characteristic to the next generation, a third planting was made using various combinations of male and female plants previously described. This planting has been set for two years, and the count of the summer stalks in 1946 followed the same pattern as in 1945, with the most vigorous plants producing twice as many stalks as the commercial varieties.

Forty-six plants died during the second year which, with the 19 that died the first year, makes a total of 63 out of 1900. Of those that died in 1946, half had shown no weakness the previous year, which brings up the question of winter-killing. There are five strains that still have a perfect stand and none of the strains have lost over 5 percent; while the two commercial varieties have lost 11 and 13 percent. These plants did not die because the crowns planted were too small, since there was no significant difference between the weight of the crowns of the plants that lived and those that died. The data appear to indicate that it is possible to breed a hardy strain of asparagus. Loss of plants after an asparagus planting has been established is one of the reasons for low yields and the low economic returns from this crop.

**Vegetable Breeding for Improvement of Quality.** (Robert E. Young, Waltham.) During the year breeding work has been conducted with broccoli, greenhouse cucumber, celery, rutabaga, New York type lettuce, tomato, carrot,

and Butternut squash. While progress has been made in the development of strains of celery, rutabaga, and greenhouse cucumber better adapted for local use, it is insufficient to justify detailed discussion.

*Broccoli.* The 1946 fall broccoli plots came into production during unseasonably warm weather with the result that many varieties and strains failed to make a marketable head. Under these conditions, a fall type, tentatively called Strain 29, was outstanding. This strain is a slow-growing type which requires so much time to produce the head that short periods of unseasonable weather have little effect on it. It was tried in the spring and found worthless. Seed has been produced for expanded fall trials and further purification.

The spring trials in 1947 showed the two strains recently developed for this season, namely Waltham No. 7 and No. 11, to be outstanding producers as an early crop. They also gave total yields considerably higher than that of the best commercial variety. The commercial variety which was best in early yield was only average when the total yields were considered; and the variety that ranked next to Nos. 7 and 11 for total yield was only 75 percent as productive in the early season.

Thus, it would seem that we have been able to retain characteristics for good early yield with the necessary vigor that makes for large total yields. Tests with growers indicate that strains No. 7 and 11 have real value, but they require a little more selection for uniformity.

*Carrot Seed Production.* The maintenance of a supply of stock seed of the Field Station strain of Hutchinson carrot has always been a part of the Carrot Breeding Project. To produce this seed, which is supplied to the carrot seed growers, a fall crop was grown and selected roots placed in a storage pit. In the spring these were re-selected for shape and external color, and internal color was observed by cutting off the bottom third of the root. Then the roots were planted in the field in early spring. By that method there was a small amount of crossing with wild carrot, and the resulting hybrids were sometimes overlooked in the seed fields in the west. This accounted for the presence of a small percentage of white, yellow, and poor-shaped roots found in the local carrot fields.

A method has now been developed whereby this seed is grown in the greenhouse with bees used as pollinators, and it is mature before the wild carrot blooms. By this procedure the off-color carrots were reduced from 2 percent in field-grown stock to none in the greenhouse crop. It is planned to supply seed producers an ounce or so of this elite stock seed, and they in turn can multiply the seed in California where wild carrots are not a problem.

The breeding of a better carrot continues, but last season work was considerably handicapped by the presence of an unusually high percentage of aster yellows which destroyed some of the best breeding lines.

*New York Type Lettuce.* The testing of Waltham Imperial Lettuce on a sufficient scale to really determine its place has been delayed by lack of seed. The seed crops, both local and that grown in California, have been disappointing.

In the 1947 crop in which early plants were set in the field, Waltham Imperial showed much more uniformity of plants and in maturity than did Great Lakes. At the time of the first cutting Great Lakes produced 55 percent marketable heads while Waltham Imperial produced 70 percent.

While Great Lakes, Waltham Imperial, and several other new strains of similar type, have about taken care of the requirements for a late set lettuce, there



remains a definite need for a first early type. Several lines are now being purified with this in mind. Even with Great Lakes, growers located away from the cooling effect of the seashore have had trouble with the lettuce crop seeded in the field due to scald, breakdown, and slime in the heads, brought on by hot weather at heading time. The experimental plantings were so affected this year, and almost 100 percent of the Great Lakes type plants which have an unprotected head were unmarketable because of breakdown. The only plants not affected were those of the so-called crinkle type which have leaves that are savoyed, and also have more protection from leaves on top of the head. A seed crop of this type of plant is being produced for more extensive trials next year.

*Trellis Tomatoes.* The work and publications of plant breeders, and the offerings of commercial seedsmen of hybrid tomato seed, have created an interest among local market gardeners. Because of market customs and preference, the type of tomatoes produced elsewhere cannot be used locally by commercial growers. To determine whether there is sufficient advantage to warrant the higher cost, five different tomato hybrids were planted. Several combinations of strains and varieties were used in a search for the best hybrid.

The early yield of the five different hybrids, all of which had as one parent either Trellis No. 22 or Waltham Forcing, was 25 percent greater than that of either of these two, which are the standard by which the hybrids must be measured. The advantage at the three-quarter harvest period had shrunk to 16 percent, and it was only 10 percent for the complete harvest.

Since the greatest returns are for early tomatoes, a difference of approximately 1 pound more per plant from the hybrids at this stage would seem to more than justify the expenditure of 1 cent per plant, which is one current quotation for hybrid tomato seed.

The fruit from some hybrids was too soft; from others too small. Considerable more testing will be required to find the best combination.

A hybrid between determinate varieties, such as Red Cloud and Victor which are very early, and Trellis No. 22, when grown by the flat culture method, produced a sufficient increase in yield to offer promise for the future for those growers who do not trellis tomatoes.

Progress is also being made in testing Selections No. 1 and 3 by growers. Selection No. 3, which has been named Waltham Scarlet, shows promise for the home garden, and will be so featured by a Boston seed firm.

*Butternut Squash.* Progress has been made towards the breeding of a strain of high-yielding Butternut squash with a minimum of crooked, cracked, and too long fruits. Inbred lines were grown during the year that produced no fruit which was too long. That same strain also had no crooked fruit. An analysis of the percentages of the various grades produced by the inbred lines shows that, if too much reduction in the length of fruit is made, an increase occurs in the percentage of culls, i.e., fruit less than 7 inches or weighing less than a pound.

The occurrence of cracks in the fruit seems to be associated with moisture supply. Cracking takes place during and after rains that break long dry periods. The tendency to crack seems to be at least partially genetic as some lines had only 5.8 percent cracked fruit while others had as much as 27 percent. There does not seem to be any association between cracking and any other grade defect, such as large or crooked fruit.

In storage experiments of an exploratory nature to determine the conditions under which to test the inbred lines for keeping qualities, loss in weight of But-

ternut squash was 29 percent at the end of 14 weeks. The greatest loss occurred in the first two weeks. Dipping the squash in a wax emulsion at harvest or two weeks later reduced the loss to 17.5 percent. Squash placed in a refrigerator at 35° F. showed very little loss in weight and kept for three to four weeks, but rot was general and complete at the end of six weeks. Other low-temperature conditions will be tested in an effort to find a means of cutting the loss on Butternut squash intended for short storage.

**Weed Control in Vegetable Crops.** (William H. Lachman.) The use of Stoddard Solvent as a weed killer in fields of carrots and parsnips has increased greatly during the past year. A survey made during 1946 revealed that about 1000 acres were kept free of weeds by this method in Massachusetts alone.

Briefly, the method consists of spraying undiluted Stoddard Solvent on weedy carrot fields at the rate of 100 gallons per acre when the carrot plants have developed one to four true leaves and while the weeds are small; that is, not more than two inches tall. Best results are obtained when the oil is applied with a nozzle that delivers a flat-fan spray at 75 to 100 pounds pressure. Hand weeding has been eliminated except where ragweed is prevalent. For some unexplained reason, ragweed is not killed along with the other weeds.

Susceptible plants are killed very rapidly. They begin to wilt a few minutes after spraying and are dead within two or three days. The spraying usually results in a slight over-all bleaching effect on the green color in the carrot plants. This does not appear to be associated with any damage to the plants, and the darker color that is characteristic of unsprayed plants usually returns within ten days.

Sometimes one or more of the older leaves in the outermost whorl of young carrot plants were rather seriously scorched or burned as a result of spraying with Stoddard Solvent. It has been rather definitely established that this damage was most apt to occur after the plants had been sprayed while wet from a rain or heavy dew. Repeated tests indicated that the yields of sprayed carrots were not affected adversely, and there was no apparent differential susceptibility among sixteen varieties and strains that had been sprayed three times with oil.

Consumers often complain that California-grown carrots taste of oil, but we have had no rejections of sales nor adverse comment from 1500 acres grown and sprayed with oil in Massachusetts during the past two years.

Of the various Umbelliferous crops tested, carrots displayed the greatest resistance to damage from Stoddard Solvent, but even carrots are damaged when sprayed after the roots attain a diameter of  $\frac{1}{4}$  to  $\frac{1}{2}$  inches. When sprayed after this stage the oil often destroys the heart of the plant and may envelop the core of the root. Parsnips were sprayed with relatively little injury up to the 4-leaf stage, but they were badly injured when sprayed in later stages of development.

Small celery seedlings grown out-of-doors were resistant to Stoddard Solvent but were damaged beyond recovery when sprayed after the 2-leaf seedling stage. Parsley, fennel, caraway, coriander, dill, celeriac, and parsnip-rooted parsley were also resistant to the oil in their early growth stages.

Injury to the growing point of various Umbels from Stoddard Solvent seems to be associated with the development of the characteristic hollow or groove on the top side of the petiole which directs the flow of oil down to the growing point of the plants where the rate of evaporation is low, and here the oil damage is at the maximum.

Stoddard Solvent killed such crops as beets, spinach, beans, corn, cabbage, lettuce, and onions, except where it was applied to the ground before the plumules

of these crops emerged. A number of chemicals showed promise as pre-emergence sprays on these crops.

The new hormone weed killer, 2, 4-D, was most damaging to all vegetable crops except corn. When applied just after the corn was planted, 2, 4-D controlled grassy and broad-leaved weeds without appreciable damage to the corn. When applied after the weeds had started growing, 2, 4-D killed only broad-leaved weeds.

### **Breeding Sweet Corn, Peppers, and Field Tomatoes for Massachusetts.** (William H. Lachman.)

*Sweet Corn.* Considerable attention has been paid to the selection of especially early types of sweet corn as well as those that exhibit good flavor and tenderness of pericarp. Several thousand plants were self-pollinated during the year to stabilize the various factors sought within the strains. Several hundred hybrids that were produced from inbreds of this station as well as from several other experiment stations have been tested and compared with existent commercial types.

One of the most outstanding of these hybrids resulted from a cross between Connecticut 27, an inbred out of Whipples Yellow, and Massachusetts 32, an early type of Purdue 39. This hybrid is midseason in maturity and the plants produce an excellent yield of large attractive ears.

Another hybrid which is especially noteworthy resulted from crossing Connecticut 3 with Massachusetts 2410-191. For two years this hybrid has matured earlier than any other variety in our trials. The seed is being increased for test on a large scale.

Considerable attention has been paid to an unusual type of corn called supersugary. Several strains of this type are approaching uniformity and should provide very sweet types of corn.

An interchange of breeding material among members of the Northeastern Corn Breeding conference has made a great deal of valuable material available for further breeding work. Several of the strains obtained in this manner combine very well with some of our inbreds, but further testing is necessary before this material can be made available for distribution.

*Peppers.* Further selection work has isolated a number of promising strains of peppers but they are not yet sufficiently uniform to send out for trial. One of these is of the Worldbeater type and has very attractive fruit with thick flesh. This appears to be resistant to certain strains of tobacco mosaic. Another strain resembles the variety Merrimac Wonder very much and it is also resistant to some strains of tobacco mosaic. Definite progress is being made in developing strains that are mosaic resistant.

*Tomatoes.* A large number of advanced generation selections from crosses among such varieties as Bounty, Earliana, Pennheart, Valiant, Bestal, and Firesteel have been carried along for several years. Very little work has been accomplished during the year because of a most severe infestation of late blight. It was clear that none of the selections exhibited any resistance to this disease. A few early fruits escaped the disease to allow for one more generation of selection. Several  $F_1$  hybrids were included in the variety trials and a few of these were rather outstanding in yielding ability. Of the hybrids under test, Fordhook Hybrid, performed especially well during the early part of the season.



**The Culture and Nutrition of Vegetables.** (W. H. Lachman.)

1. Tomato plants grown in plots mulched with manure did not succumb to foliage diseases (particularly late blight) as badly as those mulched with straw or those grown without mulch. Sugar cane fibre used as a mulch continued to have a marked depressing effect on the growth and yield of tomato plants.

2. Red Cloud and Pennheart produced more early fruit than any other tomato varieties in this year's trials. Cracking of fruit has been the most important factor in lowering the grade of out-door tomatoes. A rather late variety named Crack-Proof was practically free from cracking this year.

3. The variety Fordhook 242 lima bean outyielded all other varieties in our trials. This variety has consistently performed well in our plots.

4. The use of a plant hormone applied as a spray significantly increased the set of greenhouse tomatoes. About 50 percent of the fruits were seedless and many had objectionable air pockets where one would ordinarily expect to find pulp.

5. Carotene analyses of carrots continue to indicate wide differences among the varieties. Morse's Bunching and Imperator are among the highest in carotene content. Roots of all varieties increased in carotene as the growing season advanced, and roots stored for five months contained appreciably higher amounts of carotene on a fresh weight basis than when they were placed in storage.

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**DEPARTMENT OF POMOLOGY**

R. A. Van Meter in Charge

**The Influence of Various Clonal Rootstocks on Apple Varieties.** (J. K. Shaw and W. D. Weeks.) For the fourth successive year there was frost damage in the large stock-scion orchard. It requires many years to determine the value of these stocks for the many varieties in cultivation. At present we believe that Malling I and II are the most desirable for commercial orchards where the grower desires trees not so tall as ordinary seedling-rooted trees. They stand winds nearly as well as seedling-rooted trees, require a little less space, begin to bear younger, and give larger acre yields. Malling VII is promising but we have not had as much experience with it. It is believed that Malling XVI is superior, at least for McIntosh, but it dwarfs the trees little or not at all. Trees on Malling IX are excellent for home gardens but many require support. They are not recommended for commercial orchards.

The question of varietal adaptation is complicated and requires further study. In general, the best varieties for dwarf and semi-dwarf trees are those that make moderately vigorous growth. The very vigorous ones, such as Gravenstein and Baldwin, tend to overgrow the stock; and the weaker ones, like Duchess and Wagener, do not begin to bear much earlier than they do on seedling roots. Northern Spy and Yellow Delicious are among the best varieties to grow on dwarfing roots.

Two papers were published in Volume 48 of the *Proceedings of the American Society for Horticultural Science*.

**Lethal Incompatibilities Between Clonal Stocks and Varieties of Apples.** (J. K. Shaw and W. D. Weeks.) It was reported last year that buds from shoots of the normal strain G which had grown in the top of a tree of the lethal strain

R were still alive. Later in the summer all the trees of this hitherto normal strain died in typical fashion. This seems to prove that the lethal factor in strain R had passed into strain G and indicates that the lethal factor is of a virus nature. If this is true, no vector is present in our nursery, or the virus can be transmitted only by actually transferring virus tissue to a healthy tree. This is the first indication we have observed that a healthy tree can acquire the lethal factor.

The observation that Blaxtayman budded on Spy 227 grows vigorously the first year and then dies has been confirmed. Trees of several lethal strains were budded on Spy 227 interstock, on Spy 227-2 and on Spy 227-12. Those with Spy 227-12 roots grew much better than those on Spy 227-2 roots.

**Tree Characters of Fruit Varieties.** (J. K. Shaw, A. P. French, O. C. Roberts, and W. D. Weeks.) The examination of fruit-tree nurseries for trueness-to-name, which began in 1921, still continues. This inspection was extended to Tennessee and Alabama last year and in 1947 will extend to Iowa and Kansas, and include about 30 different nurseries. Although many of these nurseries have been examined annually for many years and the misnamed trees eliminated, still new mixtures appear. But these are detected at once, which practically prevents propagation and distribution to growers. New varieties appear and must be studied; thus this project is one that has no end.

**Effect of Orchard Mulches on the Plant Nutrients in the Soil.** (J. K. Shaw and W. D. Weeks, in cooperation with the Chemistry Department.) This project has been interfered with by the war. Soil samples were taken this year and the hay mulch applied. The trees with hay mulch look the best and the unmulched trees the poorest. Further comments on this project may be found in the Report of the Chemistry Department.

**The Nature of Winter Hardiness in the Raspberry.** (J. S. Bailey, A. P. French, and R. A. Van Meter.) It seemed possible that there might be a relationship between the rest period of raspberries and the amount of cold the plants will stand in winter; therefore, a study of the rest period was started three years ago. Each fall during November and December raspberry canes of six varieties were brought into the greenhouse at regular intervals and the time necessary to force the buds into growth was determined. From this work the following conclusions can be drawn: (1) The deepest rest, when the buds are hardest to start, is reached about November 1. (2) The time at which the deepest rest is reached is dependent on both the variety and the season, but the season is the more important factor. (3) The buds come out of the rest gradually, the rate depending mostly on the variety and to a lesser degree on the season. (4) The time the buds are through the rest period depends largely on the time they went into the rest and hence on the season. It depends to a lesser extent on the variety. (5) Those varieties which are most resistant to winter cold are usually the slowest to come out of the rest period. This suggests a relationship between rest period and cold resistance. Varieties which are least irritable, that is, are least apt to be started into growth during warm periods in the winter, are most cold resistant.

**Blueberry Culture.** (J. S. Bailey.) The attempt to control mummy berry by spraying with Fermate was continued in 1946. Some bushes received six, some seven, some eight, and some nine sprays. Primary infection of shoots and blossom clusters was much lighter than in 1945. There were also fewer mummied berries on the unsprayed bushes than in 1945. Although the differences among

the various numbers of sprays were too small to be significant, the spraying definitely reduced the number of mummies. This work is being continued.

In the experimental plantings there are a number of bushes infected with blueberry stunt, a virus disease. These are being kept to watch the progress of the disease. As yet, there has been no evidence of any spread from diseased to adjacent healthy bushes. However, the progress of the disease in an infected bush is much more rapid than had been anticipated. So far diseased bushes have been found in only two varieties, Cabot and Concord. Since the symptoms differ in each variety, buds from diseased bushes were set in healthy bushes of several other varieties so that the symptoms might be studied as they developed.

An infestation of a Lecanium scale had been slowly building up, particularly on the variety Concord. Previous attempts to control it had been only partially successful. In the spring of 1947 delayed dormant sprays of DDT emulsion, D-542, and "Peninsula Oil" were applied in cooperation with the Entomology Department. The DDT emulsion had little effect, "Peninsula Oil" killed most of the scale, and D-542 eliminated them almost completely.

**Nutrition of the High-Bush Blueberry, Especially in Relation to Soil Reaction.** (J. S. Bailey.) For many years it was believed that manure would kill cultivated blueberry bushes. A comparison of horse, poultry, and cow manure over a period of five years has shown that (1) the bushes will thrive where as much as 20 tons of horse manure per acre are applied, and (2) there is no significant difference among manures when they are used in such quantities as to give about the same amount of nitrogen per acre. This phase of the work has been concluded.

In the summer of 1946, leaf symptoms of what appeared to be magnesium deficiency were observed on a few blueberry plants. Chemical analyses of the leaves of several bushes revealed that they contained only 0.14 percent magnesium or less. With the apple, 0.20 percent is considered the danger line. When the analysis gets that low, an effort should be made to get more magnesium into the tree. This situation in blueberries is being studied further.

**Magnesium Deficiency in Massachusetts Apple Orchards.** (J. K. Shaw and W. D. Weeks.) The leaf scorch typical of this deficiency has been little in evidence during the past three years. This is not saying that magnesium deficiency is no longer present. Probably it may interfere with best growth and fruitfulness and still no serious leaf scorch be present. Moderate to heavy applications of Epsom salts were applied to a large number of trees and leaf samples from 110 trees collected for analysis. The analytical work is not yet completed, but so far there is little indication of success in getting magnesium into these mature apple trees. The recommended measures to alleviate magnesium deficiency are still 20 pounds of Epsom salts in 100 gallons of the regular spray solution applied in three or four of the earlier foliage sprays for immediate results, and dolomitic limestone, 1 to 2 tons per acre, for more lasting results.

**Thinning Apples with Sprays.** (W. D. Weeks.) Because of a light bloom in most of the Station orchards and injury to blossoms from spring frosts, extensive trials to thin apples with sprays were not attempted in 1947. However, some results were obtained with a commercial preparation of naphthalene acetic acid, 20 p.p.m. Early McIntosh, Golden Delicious, Red Astrachan, Wealthy, and Lobo were thinned quite effectively; while Kendall, Melba, Blackmack and Richared were thinned excessively. Considerable dwarfing and distortion of the



leaves was caused by the naphthalene acetic acid on Wealthy, Early McIntosh, and Melba; while Golden Delicious, Richared, Blackmack, Red Astrachan, Kendall, and Lobo varied from no apparent injury to moderate injury.

Limited trials were also made with a new thinning mixture which the Delaware Station reported as showing much promise. The mixture consisted of polyethylene polysulfide (Goodrite p.e.p.s.) and a complex product of zinc dimethyl dithiocarbamate "Zimate" with cyclohexylamine. It was used at the rate of 2 pounds of Goodrite and 1/8, 1/4, and 1/2 pound of the "Zimate" complex per 100 gallons. Applications were made on single branches of several varieties at one and two weeks past full bloom. Under the conditions of the test none of the sprayed branches showed a significant reduction in set over the checks.

**Chemical Control of Poison Ivy and Other Weeds.** (J. S. Bailey.) Poison ivy is often a serious pest in orchards where it grows under fruit trees, often in rank profusion. Workers are sometimes seriously poisoned when picking up dropped fruit at harvest time or when working in the orchard at other times. During 1946, several materials were used as sprays in an attempt to kill this pest. Four formulations of the new weed killer, 2, 4-D, were tried. Two of these were esters, one a butyl and the other a methyl ester. Both of these were tried at the usual strength of 1,000 p.p.m. and at 2,000 p.p.m. None of the four formulations was effective. Mixtures of several different concentrations of ammonium thiocyanate with tar acid oil and kerosene were tried. These killed only the tops and new tops developed from the old roots. A proprietary mixture of sodium chlorate and a deflagration agent was also tried, used at 1 pound per gallon of water. This was more effective than the 2, 4-D sprays but eradication was not complete. As in 1945, ammonium sulfamate proved to be the most effective eradicator for poison ivy. At  $\frac{3}{4}$  pound per gallon it was 90 percent effective, and at 1 pound per gallon it was almost 100 percent effective.

American bamboo (*Polygonum Seiboldii* De Vriese) is one of the most persistent and fast growing weeds imaginable. It is not a common weed, but where it has become established, it can take over large areas in a short time. Two ester formulations of 2,4-D at single and double strength were tried, without effect other than a little twisting of the tender tips. Two applications of ammonium sulfamate at 1 pound per gallon, the first June 26 and the second August 8, failed to kill this pest.

Ammonium sulfamate is very toxic to peaches and cultivated blueberries but harmless to apple trees four years old or older when sprayed on weeds under them. Its effect on four-year-old pear, plum, and cherry trees was tested by applying the spray on the weeds around them at 1 pound per gallon, 1 gallon per 100 square feet. One spray was applied June 25 and a second September 6. No visible effects have been observed on the trees; so that material appears to be safe for use around cherries, plums, and pears, at least after they are four years old.

A proprietary mixture of sodium chlorate and a deflagration agent was also found to be safe around four-year-old cherries, plums, and pears when used at 1 pound per gallon, 1 gallon per 100 square feet. This mixture is toxic to cultivated blueberries.

Witch grass, sometimes called quack grass or twitch grass, is often a problem around young trees in an orchard. Previous experience indicated that fall applications of ammonium sulfamate were more effective than summer applications. A series of plots was laid out in the summer of 1946 to test the effectiveness of ammonium sulfamate and a proprietary mixture of sodium chlorate at different

times, at different concentrations, and at different rates of application. It was found that ammonium sulfamate at  $\frac{3}{4}$  pound per gallon or the chlorate mixture at  $1\frac{1}{4}$  pounds per gallon, used at the rate of 1 gallon per 100 square feet, did a 95 to 100 percent job of killing the witch grass. In the summer of 1947 it was observed that the witch grass came back into the plots from around the edges faster in the ammonium sulfamate plots than in the chlorate mixture plots.

A butyl and a methyl ester formulation of 2,4-D were tried on chokecherry at 1,000 p.p.m. and at 2,000 p.p.m. in August, 1946. The materials were equally effective, and single was as good as double strength. Growth of the treated bushes was very weak and very abnormal in 1947. Leaves were very narrow, curled, very sharply serrated, and mottled. Fruiting stems made an abnormally vigorous growth but died without producing fruit.

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## DEPARTMENT OF POULTRY HUSBANDRY

F. P. Jeffrey in Charge

**Broodiness in Poultry.** (F. A. Hays and Ruby Sanborn.) Selective breeding has not been successful in entirely eliminating the broody instinct in Rhode Island Reds. A limited life span particularly in males, no manifestation of the character in males, and incomplete progeny testing because of deferred broodiness offer many difficulties. The fact has been clearly demonstrated that broodiness depends upon two dominant complementary genes and that quantitative factors affecting the degree of broodiness are in operation. There is a definite linkage between broody genes and intensity of laying, and clucking without cessation of laying has been shown to indicate broody inheritance. Females should be tested for at least three laying years to discover their phenotype for the broody instinct. The last generation to complete its first laying year exhibited no broodiness in the daughters of one 36-month-old sire; but the other sire, 24 months old, gave one broody daughter from a hen of the same age. These daughters are being retained for a further performance record.

**The Effectiveness of Selective Breeding to Reduce Mortality in Rhode Island Reds.** (Regional Poultry Research Laboratory and Departments of Veterinary Science and Poultry Husbandry, Massachusetts Agricultural Experiment Station, cooperating.) Results of breeding high and low mortality lines through three generations were completed in November 1946. The two lines differed significantly in mortality rates to eight weeks, from eight weeks to six months, and from six to eighteen months in both sexes. The low mortality line exhibited a higher mortality rate than the control line during the same period. Complete data are ready for publication.

**Genetic Laws Governing the Inheritance of High Fecundity in the Domestic Fowl.** (F. A. Hays and Ruby Sanborn.) A number of phases of the problem of breeding for high fecundity have been studied. The value of egg records as a criterion for selecting breeding females was reported in *Poultry Science* for November 1946. The accuracy of limited trapnesting has been investigated and results reported in Station Bulletin 438. Further consideration has been given the problem of intensity, particularly from the inheritance standpoint, and the report is being published as a Station bulletin. The data point to the importance of heredity in developing high intensity. There is no evidence of sex-linked genes being

concerned. A special study is being made of the value of progeny testing in breeding for high fecundity, and of the possible effect of air temperature on egg size in Rhode Island Reds.

Early sexual maturity, very low broodiness, and high persistency are well fixed in the flock, but intensity and incidence of winter pause remain variable. Efforts are being made to reduce variability in egg production by a search for inherited factors operating.

**A Study of Fertility Cycle in Males.** (F. A. Hays.) Synthetic thyroxin was used in the spring of 1947 to activate males of various ages to higher fertility. Artificial light was also tested. Results showed that the hormone was not quite so effective as artificial light. Cockerels have not been affected by any agents used.

The complete report of this and previous years' tests is now in press.

**Genetic Analysis of Rhode Island Red Color Inheritance.** (F. A. Hays.) This project was completed in the fall of 1946. Colorimetric analysis of intensity of soluble feather pigment suggests that less intense pigmentation depends on several dominant genes. A complete report is ready for publication.

**Secondary and Adult Sex Ratio in Relation to Hatchability.** (F. A. Hays.) High and low hatchability lines have been developed through the third generation, but have not yet been carried long enough to be definitely established. A search for lethals responsible for low hatchability and abnormal sex ratios has not been very fruitful as yet. Preliminary evidence indicates, however, that sex differences in embryonic mortality rates play considerable part when secondary sex ratios are abnormal.

**Breeding for High and Low Incidence of Internal Defects in Hen's Eggs.** (F. P. Jeffrey and C. E. Walker.) Strains of Rhode Island Reds have been bred which differ significantly in incidence of meat spots in their eggs. Continued selection will be practiced to further differentiate these strains. There is a small but significant association between incidence of meat spots and degree of shell color, the eggs with darkest shell color tending to carry more meat spots than those with the lightest shell color. Egg shell color varies widely in these strains.

**Breeding White Plymouth Rocks for Eggs and Meat.** (F. P. Jeffrey.) A strain of White Plymouth Rocks has been developed which is pure for the Columbian pattern; that is, males of this strain when mated with Rhode Island Red or New Hampshire females give red pullets and "Columbian" males.

**Hatchability Factors in Products of Vegetable Origin-Distillers' Dried Solubles as Supplements to Soybean Meal Rations.** (Marie S. Gutowska.) Two types of basal rations were used in making up the eight experimental rations. Type I consisted largely of corn and soybean meal supplemented with methionine and choline and small amounts of alfalfa meal. Type II contained less soybean and corn meal but included also wheat bran and oats. Mineral and vitamin supplements were added to both types on an equal basis. Soludri regular and Soludri 3N (Distillers' Dried Solubles), both fermentation products of vegetable origin, were the materials tested for their value as supplements.

The results demonstrated clearly that, whereas the basal Type I ration maintained hatchability at a low level of 49 percent of fertile eggs, the hatchability was improved considerably (36 percent) when a supplement of 3N Soludri was



added. However, hatchability increased only 26 percent when Soludri regular was added, either with or without fish meal. It seems, therefore, that the necessary hatchability factor(s) could be provided by the addition of distillers' fermentation products to a ration of Type I, and that in some cases fish meal does not contribute additional hatchability factors.

The value of the supplements was less pronounced in raising hatchability on rations of Type II. The basal ration maintained hatchability at 63.5 percent level. The addition of Soludri increased the hatchability 16.5 percent; but, in order to obtain a good hatchability (87 percent), it was necessary to add 2.5 percent of fish meal in addition to 5 percent Soludri. In this case, the unknown hatchability factor(s) could not be produced without adding a protein of animal origin.

This study suggests the need for further attempts to work out a basal formula for high hatchability laying rations deriving their protein from vegetable sources only. Apparently soybean meal rations of Type I can be used successfully when supplemented with Soludri, especially Soludri 3N, possibly because this supplement may create favorable conditions for microorganisms and synthesis.

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## SEED CONTROL

Frederick A. McLaughlin in Charge

The Massachusetts Agricultural, Vegetable and Flower Seed Law was amended in 1946 and became effective on August 24 of that year. More comprehensive requirements of the amended act, together with a growing appreciation by the public of the merits of tested seed, resulted in a greatly increased number of samples received by the laboratory over any previous year. From July 1, 1946, to June 30, 1947, 5,853 samples were received and worked in the seed laboratory; an increase of 679 samples over the previous year. The laboratory also received and cleaned 100 lots of tobacco seed.

Enforcement of the Seed Law, together with an increased interest in good seed on the part of seedsmen and the public, has resulted in more correctly labeled and better quality seed being offered for sale. In 1947 only 1.94 percent of the vegetable seeds sampled by a State inspector and tested at the seed laboratory were found to be below standard. There has been a marked increase in the number of samples above standard each year since 1936 when 28.36 percent were found below.

Operation of the Seed Law is reported in an annual bulletin issued for that purpose.

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## DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

**Poultry Disease Control Service.** (H. Van Roekel, K. L. Bullis, G. H. Snoeyenbos, O. S. Flint, F. G. Sperling, M. K. Clarke, O. M. Olesiuk, and E. M. Allen.)

1. *Pullorum Disease Eradication.* During the year 1946-47, a total of 1,271,378 blood samples was tested—1,238,983 from chickens, 19,796 from turkeys and 12,599 from other fowl. A total of 651 chicken and turkey flocks was tested. The percentages of positive tests were 0.13 for chickens, 0.51 for turkeys, and 0 for other fowl tested. There was a slight increase over the previous season in the number of flocks and samples tested.

It is encouraging to note that the pullorum disease status of Massachusetts poultry flocks has steadily improved during the past six years, even though both the poultrymen and the laboratory have been faced with many difficulties. Massachusetts can feel proud of the fact that 95 percent of the chickens tested are in 100 percent non-reacting flocks.

2. *Diagnostic Service.* During the calendar year of 1946, 4763 specimens were received in 858 consignments, of which 448 were delivered in person. The specimens were classified as follows: 4028 chickens, 642 turkeys, 18 pheasants, 17 rabbits, 11 each of bovine semen and canine feces, 10 each of ducks and pigeons, 7 quail, 3 trout, 2 bovine organs, and 1 each of bovine blood, bovine fetus, canary, and swine.

Coccidiosis (105), tumors (64), pullorum disease (58), fowl paralysis (37), and Newcastle disease (47) were the disturbances identified most frequently. A definite diagnosis was not reached in 46 outbreaks of respiratory disease. Avian tuberculosis was not identified during the year. Fowl cholera was identified in 19 instances, including 10 new premises. Fowl typhoid was recognized 19 times, and 17 were on premises where the disease was not known to have existed previously. There were fewer cases of cholera and more of typhoid than in the previous year.

Cockleburs caused severe injury in one group of chicks three weeks of age. Péanut shell litter containing cockleburs had been added to the litter already on the floor, and the chicks began eating the burs almost immediately. As many as five were found in some of the chicks examined. The cockleburs caused severe mechanical injury and inflammation at the site of lodgment, usually the lower esophagus.

The 642 turkeys were received in 140 consignments. More than half of the examinations were on birds less than four weeks old. Coccidiosis, paratyphoid infection, pullorum disease, and swine erysipelas were the conditions encountered most frequently.

The number of cases of *E. rhusiopathiae* infection (swine erysipelas) in turkeys called to the attention of the laboratory equalled that of the previous ten years combined. In previous years the outbreaks had occurred principally on porches in September and October or on range in November and December. In 1946 one outbreak occurred in February in housed breeders, and several were on range during the summer and early fall. The latter outbreak continued for some time and one owner reported losses of approximately 12 percent.

3. *Flock Mortality Studies.* Necropsies were made on 225 birds from the Experiment Station flock, including 141 females, 76 males, and 8 unidentified of the group hatched in the spring of 1945. No new observations of significance were made on examinations of these birds.

4. *Infectious Bronchitis Control.* During 1946, 217 flocks were enrolled in the infectious bronchitis control program. The results continue to be satisfactory, and the flock owners regard this control program as a valuable service to the industry. During the year birds from 101 flocks were tested for their immunity to infectious bronchitis, 64 of which were found to be immune, 35 susceptible, and 2 questionable.

Furthermore, 114 flocks were tested for Newcastle disease with the serum-virus neutralization and hemagglutination-inhibition tests; and 47 were found positive, 64 negative, and 3 questionable. When indicated, attempts were made to isolate

the virus from tissues of infected birds. The disease was identified in Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Plymouth, Suffolk, and Worcester counties. Whenever possible, complete case histories on natural outbreaks are being collected, and that information should be helpful in investigating and controlling this disease.

In 8 flocks, eggs collected during active outbreaks of Newcastle disease were examined for the presence of virus. Among 256 eggs examined, the virus was recovered from 34 eggs received from 4 flocks.

Preliminary studies reveal that birds recovering from exposure to the Newcastle virus will give a positive test with the hemagglutination-inhibition test (H I) in a shorter time than with the serum-virus neutralization test. Hemagglutination inhibiting bodies have been found in sera of birds as early as five days after artificial infection. The H I test should prove of great value in the early diagnosis and control of the disease.

A few flocks (approximately 10,000 birds) were vaccinated with a commercially produced, killed vaccine. The vaccine failed to induce a definite immunity.

A limited number of experiments was conducted to determine whether eggs selected during the active and terminal stages of an outbreak of Newcastle disease would produce infected chicks on hatching or during the first two weeks of the brooding stage. The trials conducted thus far have yielded negative results. This phase of the disease is being investigated further since the virus has been detected in fresh eggs, and field observations have led to the recovery of the virus from two-day-old chicks.

5. *Mastitis Testing Laboratory.* At the end of the calendar year 1946, facilities for operation of the laboratory were incomplete. Plans were made to set up and test equipment early in 1947.

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## WALTHAM FIELD STATION

Waltham, Massachusetts

Ray M. Koon, In Charge

The members of the research staff of the Waltham Field Station are assigned to this branch by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Refer to reports of these Departments for results of investigations conducted at this Station.

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## PUBLICATIONS

### Bulletins

436 Annual Report for the Fiscal Year Ending June 30, 1947. 70 pp. September 1946.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.



- 437 Home Freezing in Massachusetts. By William B. Esselen, Jr., Katherine M. Lawler, and Carl R. Fellers. 27 pp. illus. October 1946.  
Home freezing of foods is arousing much interest. In Massachusetts freezing seems best suited as a supplement to other methods of home food preservation. Questions frequently asked by prospective home freezer owners are answered.
- 438 The Value of Limited Trapnesting to Poultry Breeding. By F. A. Hays. 24 pp. September 1946.  
Limited trapnesting reduces labor costs and affords a method by which breeders may secure records on larger numbers of birds. Data reported in this study indicate that safe estimates of complete performance may be made from certain short-time records.
- 439 Clearing and Improvement of Farm Land in Massachusetts. By Charles R. Creek, Joseph F. Hauck, and Virgil L. Hurlburt. 31 pp. illus. July 1947.  
The primary purposes of this study have been to appraise the methods used in farm land improvements, to examine the results in terms of cost-benefit comparisons, and to study the significance of land reclamation for the future of agriculture in Massachusetts.

### Control Bulletins

- 128 Twenty-sixth Annual Report of Pullorum Disease Eradication in Massachusetts. By the Poultry Disease Control Laboratory. 15 pp. June 1946.
- 129 Inspection of Commercial Feedstuffs. By Feed Control Service Staff. 28 pp. July 1946.
- 130 Inspection of Commercial Fertilizers and Agricultural Lime Products. By Fertilizer Control Service Staff. 27 pp. July 1946.
- 131 Seed Inspection. By F. A. McLaughlin. 33 pp. December 1946.

### Meteorological Bulletins

- 691-702, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By C. I. Gunness, M. J. Markuson, and F. J. Sievers. 4 pp. each.

### Reports of Investigations in Journals

#### NUMBERED CONTRIBUTIONS

- 525 Effect of institutional cooking methods on vitamin content of foods. II. Ascorbic acid content of potatoes. By Anne W. Wertz and C. Edith Weir. Food Res. 11 (4):319-326. 1946.
- 567 Composition of squashes after winter storage. By Arthur D. Holmes and Albert F. Spelman. Food Res. 11 (4):345-350. 1946.
- 571 Influence of purified lignin on nitrification in soil. By James E. Fuller. Science 104 (2701):313-315. 1946.
- 577 The vitamin content of canned and cooked fresh mushrooms. By Angela M. Filios and William B. Esselen, Jr. Jour. Amer. Dietet. Assoc. 22 (9):772-777. 1946.
- 578 Nutritional status of women students. By Marie S. Gutowska and Evelyn B. Ellms. Jour. Amer. Dietet. Assoc. 22 (9):763-765. 1946.

- 579 Enhancing the riboflavin content of mare's milk. By Arthur D. Holmes. *New England Jour. Med.* 235:360-362. 1946.
- 580 Carbohydrates in cultivated mushrooms (*Agaricus campestris*). By John E. W. McConnell and W. B. Esselen, Jr. *Food Res.* 12 (2):118-121. 1947.
- 583 The use of oil sprays as selective herbicides for carrots and parsnips. II. By William H. Lachman. *Amer. Soc. Hort. Sci. Proc.* 47:423-433. 1946.
- 585 Sodium selenate for red spider control in Massachusetts. By Harold E. White and Warren D. Whitcomb. *Amer. Soc. Hort. Sci. Proc.* 47:503-506. 1946.
- 586 Fermate and its effect on rooting of geranium cuttings. By Harold E. White. *Amer. Soc. Hort. Sci. Proc.* 47:522-524. 1946.
- 588 Evaluation of tests for rancidity in edible packaged oils. By John E. W. McConnell and W. B. Esselen, Jr. *Oil and Soap* 23 (12):369-374. 1946.
- 589 Effect of storage conditions and antioxidants on the keeping quality of packaged oils. By John E. W. McConnell and William B. Esselen, Jr. *Jour. Amer. Oil Chem. Soc.* 24 (1):6-13. 1947.
- 590 Stability of vitamins in stored ice cream. By Arthur D. Holmes, John W. Kuzmeski, and Frank T. Canavan. *Jour. Amer. Dietet. Assoc.* 22 (8):670-672. 1946.
- 592 Fermate for the control of mummy berry of the cultivated blueberry. By J. S. Bailey and Thomas Sproston. *Amer. Soc. Hort. Sci. Proc.* 47:209-212. 1946.
- 593 The decomposition of certain plant tissues with and without added lignin. By Emmett Bennett. *Amer. Soc. Hort. Sci. Proc.* 47:252-254. 1946.
- 595 The influence of Malling clonal rootstocks on the growth of certain apple varieties. By J. K. Shaw. *Amer. Soc. Hort. Sci. Proc.* 48:171-179. 1946.
- 596 The anchorage of clonal stock apple trees. By J. K. Shaw. *Amer. Soc. Hort. Sci. Proc.* 48:166-170. 1946.
- 597 Bactericidal properties of some surface-active agents. By W. S. Mueller, Emmett Bennett and James E. Fuller. *Jour. Dairy Sci.* 29 (11):751-760. 1946.
- 598 Effect of storage temperature on processed and dehydrated foods. By John E. W. McConnell, C. R. Fellers, and W. B. Esselen, Jr. *The Glass Packer*, 25:714, 716-717, 800, 824-826, 828. 1946.
- 599 Egg records as a criterion for selecting breeding hens. By F. A. Hays. *Poultry Sci.* 25 (6):622-627. 1946.
- 601 Some observations on "quality" in hays. By J. G. Archibald, E. Bennett, and J. W. Kuzmeski. *Jour. Dairy Sci.* 29 (11):795-800. 1946.
- 604 Vitamin C content of hens' vital organs after long continued ascorbic acid injections. By G. Howard Satterfield, Thomas A. Bell, F. W. Cook, and Arthur D. Holmes. *Poultry Sci.* 26 (2):163-166. 1947.
- 605 The fortification of fruit juices with ascorbic acid. By William B. Esselen, Jr., John J. Powers, and Carl R. Fellers. *Fruit Prod. Jour. and Amer. Food Mfr.* 26 (1):11-14, 29. 1946.
- 606 The protection of lilies against damping off. By William L. Doran. *Natl. Hort. Mag.* 25:4:385-386. October 1946.
- 607 Firmness in frozen sliced apples. By William B. Esselen, Jr., W. J. Hart, Jr., and C. R. Fellers. *Quick Frozen Foods* 9 (5):66 (II), 1946.
- 608 Preparation of holocellulose from nonwoody plant material. By Emmett Bennett. *Analytical Chem.* 19:215. 1947.
- 609 Relationship of seed plant development to the need of magnesium. By Walter S. Eisenmenger and Karol J. Kucinski. *Soil Sci.* 63(1):13-17. 1947.

- 610 Food value of hormone-treated tomatoes. By Arthur D. Holmes, Albert F. Spelman, John W. Kuzmeski, and William H. Lachman. *Jour. Amer. Dietet. Assoc.* 23 (3):218-222. 1947.
- 616 Cobalt in cows' milk. By J. G. Archibald. *Jour. Dairy Sci.* 30 (5):293-297. 1947.
- 619 Composition of mares' milk as compared with that of other species. By Arthur D. Holmes, Albert F. Spelman, C. Tyson Smith, and John W. Kuzmeski. *Jour. Dairy Sci.* 30 (6):385-395. 1947.

#### UNNUMBERED CONTRIBUTIONS

- Sigma XI—An ideal. By J. G. Archibald. The Society of the Sigma XI, Scientific Research Society of America, Annual Report 1945:31.
- The feed dealer—An agricultural missionary. By J. G. Archibald. *Amer. Feed and Grain Dealer* 30 (10):14-15 et seq. September 1946.
- Some lessons to be learned from the feed shortage. By J. G. Archibald. *New Eng. Farm Finance News* 1 (10):4. October 1946.
- Now we're learning what it takes to feed a cow. By J. G. Archibald. *Eastern States Cooperator* 22 (11):11-14. November 1946.
- Roughage as a factor in winter feeding. By J. G. Archibald. *Canad. Jersey Breeder* 2 (1):14 et seq. December 1946.
- This feed shortage. By J. G. Archibald and F. H. Branch. *Mass. State Coll. Ext. Serv. Spec. Cir.* 141. July 1946.
- Control of damping-off by a delay in first watering after seeding. By William L. Doran. *Phytopath.* 36:8:679. August 1946.
- Fungicides applied in fertilizer for the control of cabbage clubroot and damping-off. By William L. Doran. *Ann. Meeting Northeast. Div. Amer. Phytopath. Soc.*, November 26, 1946. (Abstract will appear in *Phytopathology*.)
- Present status of the Dutch elm disease in New England. By Malcolm A. McKenzie. Report for 22d Conference convened by New England Council. November 22, 1946.
- Troublesome tree diseases in New England and their control. By Malcolm A. McKenzie. 22d Natl. Shade Tree Conf. Conv. Proc., Boston, August 27-30, 1946 (pp. 134-7).
- Dutch elm disease in Massachusetts. *Forest and Park News.* February 1947.
- Dutch elm disease. By Malcolm A. McKenzie. (Five progress reports—mimeographed.)
- Dutch elm disease control program in Massachusetts. By Malcolm A. McKenzie. *New Eng. Div. Amer. Phytopath. Soc.*, at Amherst, November 26-27, 1946. Abstracted for *Phytopathology*.
- Buy more from your dairy cows. By J. H. Frandsen. *The Jersey Bull.* pp. 602-603. April 10, 1947.
- Freezing McIntosh apples. By W. J. Hart, Jr., W. B. Esselen, Jr., and Carl R. Fellers. *Mass. Fruit Growers' Assoc.*, Rpt. 53d Ann. Meeting, pp. 118-121. 1947.
- As the chemist sees the apple. By Carl R. Fellers. *Ibid.* pp. 121-122. 1947.
- Abstracts of the literature of food and sanitary technology during 1946. By Arthur S. Levine. *Jour. Milk and Food Technol.* 10 (3):131-136. 1947.
- Home canning spoilage. By William B. Esselen, Jr., Mimeographed Circular, 16 pp. December 1946.
- Chemical weed killers. By C. J. Gilgut. *Amer. Nurseryman* 86 (1):42. July 1, 1947.



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MASSACHUSETTS:

↑ AGRICULTURAL EXPERIMENT STATION


BULLETIN NO. 449

SEPTEMBER 1948

## Annual Report

For the Fiscal Year Ending June 30, 1948

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The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal. 

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UNIVERSITY OF MASSACHUSETTS

AMHERST, MASS.

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# MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

## Trustee Committee on Experiment Station

	Term Expires
BRETT, ALDEN C., Belmont, Chairman	1950
COLE, FREDERICK E., Commissioner of Agriculture	
WHITMORE, PHILIP F., Sunderland	1948
HORTYZER, ERNEST, Wellesley	1950
MCMANARA, MRS. ELIZABETH L., Cambridge	1951
DEELY, JOHN M., Lee, Boston	1953
HUBBARD, CLIFFORD C., Mansfield	1953

## Experiment Station Staff, June 30, 1948

VAN METER, RALPH A., *President of the University*

SIEVERS, FRED J., Director  
GASKILL, EDWIN F., Assistant to the Director  
O'DONNELL, MARGARET H., Associate Director

HAWLEY, ROBERT D., Treasurer  
FELTON, F. ETHEL, Editor  
MALLORY, DOROTHY E., Secretary

\*ALEXANDER, CHARLES P., Entomology  
ARCHIBALD, JOHN C., Animal Husbandry  
BOURNE, ARTHUR I., Entomology  
\*BRADLEY, LEON A., Bacteriology  
BROWN, ALFRED A., Agricultural Economics and Farm Management  
BULLIS, KENNETH L., Veterinary Science  
†CHANDLER, FREDERICK B., Cranberries  
COLBY, WILLIAM G., Agronomy  
DORAN, WILLIAM L., Botany  
EISENMENGER, WALTER S., Agronomy  
\*FELLERS, CARL R., Food Technology  
†FRANKLIN, HENRY J., Cranberries  
\*FRENCH, ARTHUR P., Pomology  
FULLER, JAMES E., Bacteriology  
\*GAMBLE, PHILIP L., Economics  
\*GASKILL, EDWIN F., Station Service  
\*GUBA, EMIL F., Botany  
\*HANKINSON, DENZEL J., Dairy Industry  
HARRIS, WILLIAM K., Veterinary Science  
HASKINS, HENRI D., Agricultural Chemistry (Professor Emeritus)  
HAYS, FRANK A., Poultry Husbandry  
\*HOLDSWORTH, ROBERT P., Forestry  
HOLLAND, EDWARD B., Chemistry (Professor Emeritus)  
HOLMES, ARTHUR D., Chemistry  
\*JEFFREY, FRED P., Poultry Husbandry  
KIGHTLINGER, CLIFFORD V., Agronomy  
\*KOON, RAY M., Horticulture  
\*KUZMESKI, JOHN W., Dairy, Feed and Fertilizer Laws  
\*LENTZ, JOHN B., Veterinary Science  
\*LINDSEY, ADRIAN H., Agricultural Economics and Farm Management  
MCKENZIE, MALCOLM A., Botany  
\*MITCHELL, HELEN S., Home Economics  
\*OSMUN, A. VINCENT, Botany  
\*RICE, VICTOR A., Animal Husbandry  
\*RITCHIE, WALTER S., Chemistry  
ROZMAN, DAVID, Economics  
SHAW, JACOB K., Pomology (Professor Emeritus)  
\*SIELING, DALE H., Agronomy  
SMITH, PHILIP H., Agricultural Chemistry (Professor Emeritus)  
SNOEYENBOS, GLENN H., Veterinary Science  
\*SNYDER, GRANT B., Olericulture  
SOUTHWICK, FRANKLIN W., Pomology  
STAPLETON, HERBERT N., Engineering  
\*THAYER, CLARK L., Floriculture  
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# ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1947-48

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## DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

**The Effect of Public Regulation of Milk Marketing Upon the Organization of the Milksheds of Massachusetts Markets.** (A. A. Brown.) Eastern fluid-milk markets and Boston in particular again had to reach into the North Central States for supplies during the fall and winter of 1947-48. The emergency short season turned out to be the longest on record.

Transportation rates and services are a major element in establishing the cost of this milk to dealers. To the rail information on these items, an attempt was made to add similar data for trucks. Movement by truck has not been undertaken regularly between the areas studied. Some shipments have been made and rates quoted but the preferred method of transportation is via rail tank car.

Shipments made by truck to other areas have been handled on a contract carrier basis at a minimum charge per load for which a maximum volume was set; viz., Juneau, Wisconsin, to Atlanta, Georgia, \$431.50 for a load not to exceed 35,000 pounds. The comparable rail structure was \$1.18 per 10-gallon can with a minimum of 2500 gallons. Expressed in terms similar to the rail tariff, the cost by truck in this instance was \$1.06 per 10-gallon unit.

The transportation phase of this study has been completed. It has become increasingly apparent with the sustained shortages of fluid milk in the fall months that public regulation involves more than State Milk Control Boards and their Federal counterparts. Public health agencies and emergency commissions, such as the war-induced WFA and OPA, need, where possible, to integrate their objectives with those of the group regularly responsible for public milk supplies.

**A Study of Farm Real Estate Taxation, Methods of Taxation Reform, and the Effect of Such Measures on Farm Income.** (A. A. Brown and Avery A. Arnold.) Unreasonable variations in the valuation of farm property are due primarily to the basis on which valuations are made. Market value for tax purposes is difficult to determine at any time, and in periods of rising or falling prices practically impossible. A revision in point of view appears necessary if the inequities due to subjective valuation are to be minimized.

Real property for taxing purposes has a specific value; a value which may but probably will not be identical with market value. If this premise is tenable, the development and utilization of a classified property tax system would be a big step towards less unexplained variation in valuations.

Personal property for taxing purposes may have valuations determined even more realistically. But again agreement on the validity of the basic premise is a prerequisite. Market values as now used are nominal. They assume the exchange of the personalty, generally livestock, for its continued use unchanged except for ownership. The shortcomings of such assumptions appear in the variations in valuations. A common denominator for livestock of various kinds is its salvage value. The butcher's block is the great leveler. Since valuations

are established but once a year and since actual market values are published regularly, average meat values at primary markets—Boston, for example—during the month of November or December would be a more equitable value to apply.

For other personal property, especially machinery, a schedule of values could be devised similar in structure to that used for determining excise taxes on motor vehicles. Much machinery appears to be overlooked altogether, and one reason for this may be the difficulty of determining a reasonable value.

**Marketing of Hatching Eggs.** (A. A. Brown, B. E. Brown, and J. A. Ward.) Although not all the field schedules have been taken, some preliminary observations can be made.

The hatching-egg industry is made up of several components: broiler-hatching, flock replacement, foundation stock – R.O.P.

Under some conditions eggs from any mated pens go into broiler-hatching. Generally, however, buyers locally or in the principal outlet area—the Del-Mar-Va peninsula—determine the matings. The constant effort maintained by the broiler industry towards improving the product it sells adds to the hazard of specifying preferred matings. If producers of broiler-hatching eggs can anticipate these demands, their marketing problems become fewer. On a slow market, matings rather than price regulate the sale of broiler-hatching stock. Currently, stock of Barred Rock males mated with New Hampshire Red females is preferred by broiler-raisers. Since there is now some market for broiler-hatching eggs the year round, poultrymen with this stock are in a favorable position marketwise.

Seasonally the broiler-raising industry offers some opportunities to other Massachusetts flock owners who choose to take the risks involved. During late winter and in the spring when hatchings are being made here for replacement stock, the broiler territory is often an outlet for cockerels. During the summer and early fall the demands for hatching eggs are such that heavy fowl matings other than the Rock-Hampshire cross more readily. Both of these operations involve a large element of uncertainty. Since both operations are supplementary to the production of replacement stock, the possibility of large gains has outweighed the possibility of smaller losses in recent years.

**Marketing of Massachusetts Potatoes.** (R. A. Fitzpatrick, A. A. Brown, A. A. Arnold and A. C. Chatel.) Preliminary work incidental to providing adequate data on supply has been completed. The make-up of the industry, the acreage grown, and the varieties planted, underwent pronounced shifts during the war years.

Many small growers came into the industry or under the support price program became identifiable. The number of potato growers increased from 10,545 to 15,313 between 1939 and 1944. The number of small growers in 1945 was 14,000. Most of the increase in number appeared in this group.

Plantings increased 7,000 acres, nearly 50 percent, between these census years. Between 1942 and 1943 commercial acreage as measured by P & MA data increased about 3,000. In subsequent years some further addition was made so that by 1944 commercial acreage had increased by 4,000 out of a total shift of 7,000.

The noticeable increase in Katahdin acreage between 1939 and 1946 was at the expense of both Cobbler and Green Mountains, although Green Mountain acreage leveled off after 1944. Acreage of Chippewa, another newcomer during the thirties, was also greater than that of Cobblers by 1945 and has held there.

Storage information is not yet complete; however, it appears that few Massachusetts growers have permanent facilities for late holding.

**Fluid Milk Prices in Major Northeastern Markets.** (A. A. Brown, B. E. Brown and A. C. Chatel.) Work under this project has followed two lines, both of which should lead to a better approach to pricing in markets drawing milk from a common shed. Sales, supply, and producers' price data for the Worcester and Springfield markets have been brought up to date. In fulfillment of co-operative arrangements with the New England Research Council, milk-sales data were developed on a daily basis for the flush and short seasons in 1944 in the Northeastern States. Information on the rail movement of milk and cream from various common points in the shed into the New York and Boston markets was also made available. This material supplemented that provided by the Rhode Island and Connecticut stations.

Partial analysis of the data has been made along with tentative allocation of milk and cream sheds among the various markets.

Philadelphia's low price with the substantial differences at major markets to the North and South of it is one of the potentially more significant findings. The assumption had been that New York City was or would be the base market.

Of additional interest will be the closeness with which the theoretically determined short-season milk and cream supply areas approximate the historical relationship for Boston and New York.

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## DEPARTMENT OF AGRICULTURAL ENGINEERING

H. N. Stapleton in Charge

### Forage Handling Investigations. (H. N. Stapleton.)

*Barn Hay Drying.* The application of high-volume fans supplying unheated air for mow drying has been made for the purpose of improving the efficiency of the barn drier. Since farm electric lines usually limit the size of electric motors to 5 or  $7\frac{1}{2}$  HP a fan selection which increases air volume per horsepower permits greater drying capacity with this limited power.

By pretesting large-diameter 2-blade propeller fans in a blast-gate tunnel, a tentative selection of satisfactory sizes for 3 HP and 5 HP motors has been made. Wind tunnel work also showed that, without the standard 1-diameter length of discharge tube permitted by the manufacturer's test code for determining fan ratings, a standard fan will not deliver the air volume of which it is capable when the tube is applied. The use of additional mounting rings from larger diameter fans to bell-flare the inlet was significant in improving the performance of the fan except near free delivery and near blockoff. The bell-flare also decreased significantly the noise level of these fans. No significant advantage could be found from the use of a  $\frac{1}{4}$ -diameter torpedo hub mounted in the discharge tube.

The application of 5 HP on a 2-blade 54" propeller fan with 60" ring and 1-diameter length discharge tube added proved satisfactory in one of the barn mows on the University Farm. Serving a 34' x 72' mow through a centrally located main duct, slatted its entire length, a maximum static pressure of  $7/16$ " water column was developed. The calculated delivery of the fan was 35,000 cfm or more throughout the drying period. The calculated water load placed at one time and to be removed by the forced air was 15,300 pounds. Satisfactory drying conditions were obtained.



The use of 3 HP on a 2-blade 40" propeller fan with 44" and 48" rings added, but without a discharge tube, on an air scoop for drying baled hay permitted the drying of bales on a mow floor without the use of a previously constructed air distribution system. Bale width tunnels, two bales in height, leading from the air scoop through the length of the pile of bales permitted air escape both between and through the bales with heights up to eight tiers. Satisfactory drying was obtained with calculated water loadings up to 8000 pounds. Static pressure developed within the air scoop at no time exceeded 3/8" and the calculated delivery of the fan was never less than 22,000 cfm.

Satisfactory drying is considered to be obtained when there is no mold development and when during and after the drying operation the hay emits an aroma rather than an odor. It is considered that the practical limit of water loading for these fans has been reached, as the time required to reduce the moisture content of the hay to 25 percent with these loadings has been 4 days.

**Warm Room Brooding.** (H. N. Stapleton.) The use of a hover-convector shield with a wall-mounted pipe panel has indicated that with restricted ventilation the temperature gradient across the floor of a narrow room can be made quite uniform. With this equipment, crowding to 0.3 square foot per chick, with two different ages in the room, was possible under warm room conditions. The warm room, together with the crowding, was considered to give a slower rate of both growth and feathering than was obtained with the same stock under other brooding conditions.

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## DEPARTMENT OF AGRONOMY

Dale H. Sieling in Charge

**The Fixation of Phosphate by Iron and Aluminum and Its Replacement by Organic and Inorganic Ions.** (Dale H. Sieling, Richard M. Swenson, and C. Vernon Cole.) It has been observed that hydrous oxides of iron and aluminum and solutions of iron and aluminum salts will fix phosphate by chemically combining with the phosphate at low pH values. The compounds formed were shown to be the hydrated basic phosphates of iron and aluminum represented by the formulas:  $\text{Fe}(\text{H}_2\text{O})_3 (\text{OH})_2 \text{H}_2\text{PO}_4$  and  $\text{Al}(\text{H}_2\text{O})_3 (\text{OH})_2 \text{H}_2 \text{PO}_4$ . The conclusion that the compounds were basic phosphates rather than normal phosphates was based on the observation that for each iron or aluminum ion one phosphate and two hydroxyls were required for complete precipitation. If the normal phosphate were formed, one phosphate and no hydroxyl would be required to completely precipitate each iron or aluminum ion.

The amount of phosphate which would combine chemically with one iron or aluminum ion increased as the phosphate increased up to a value where one phosphate was combined with one iron or one aluminum ion. In no instance was the ratio of phosphate to iron or aluminum in the precipitated compound greater than unity even when the amount of phosphate present was nine times that of the iron or aluminum.

Arsenate reacted with aluminum in the same manner as phosphate but was found to be about one-fifth as effective in replacing chemically combined phosphate as was phosphate in replacing chemically combined arsenate. Fluoride reacted with aluminum in the same manner as phosphate and arsenate and, when

in large excess, the fluoride caused the formation of the soluble hexa-fluo-aluminate ion. Fluoride was effective in replacing chemically combined phosphate and arsenate. The effectiveness increased progressively as the concentration increased until it was complete when the ratio of fluoride to aluminum reached six.

Organic anions were effective in replacing phosphate which had been chemically combined with iron or aluminum. Citrates, gallates, iso-ascorbates, tartrates, and mucates were particularly effective; while gluconates, hydroxybenzoates, and salicylates were less effective, and amino acids were not effective at all. Only those anions possessing the property of forming stable complexes with the iron or aluminum were effective in replacing the phosphate with which these metal ions were chemically combined.

Purified lignin and humus replaced chemically combined phosphate from basic iron phosphate. An increase in hydroxyl concentration also was effective in replacing chemically combined phosphate; however, its effectiveness was less than that of some of the organic anions.

Practical applications of the findings are suggested as follows:

1. An increase in the actively decomposing organic matter and in the pH value of an acid soil would result in the release of fixed phosphate and aid in preventing further phosphate fixation.

2. Soluble fluorides might be employed to release fixed phosphates. This would be practical in those areas where fluorides are known to be deficient in soils and water supplies. This fluoride deficiency has been shown to be related to a nutritional deficiency in both man and animals which results in the development of poor tooth and bone structure. The use of fluoride would then have the two-fold effect of releasing chemically combined phosphate and increasing the fluoride content of the crops and the water supplies.

3. Many soils are made unusable for shallow-rooted crops because of the use of excessive quantities of arsenates to control insect pests. In these cases arsenates are fixed in the topsoil in large quantities. To remove the arsenate from the topsoil and to cause its transfer into the subsoil, one could treat the topsoil with phosphates, fluorides, lime, or organic matter, or combinations of these materials. Shallow-rooted crops could then be grown on the reclaimed soils after appropriate fertilization.

**The Absorption of Chemical Elements by Food Plants.** (Walter S. Eisenmenger and Karol J. Kucinski in cooperation with C. Tyson Smith, Feed and Fertilizer Control Laboratory.) The object of this project is to determine the factors which influence the intake of elements in plants. The relative intake by plants of calcium, magnesium, potassium, and sodium was studied when applied singly and in pairs. Sulfates, phosphates, chlorides, bromides, and iodides were also determined in tissues of plants grown on soils treated with these anions.

Analysis of seedlings grown in the greenhouse showed that the addition of copper lowered the movement of magnesium from the nutrient medium and the seed to the aerial portion of the plant. When copper was applied to soil in field plots, the magnesium intake by plants was not lowered. However, when copper and calcium were applied together in the field plots, the amount of calcium absorbed by the plants was appreciably higher than where the same amount of copper and calcium was applied singly.

In another phase of this study, where sodium fluoride was applied to the soil, the fluorine content of the plants increased proportionately with the increasing rate of sodium fluoride applications to the soil.

**The Relationship of Plant Development to the Capacity to Utilize Potassium of Orthoclase Feldspar.** (Walter S. Eisenmenger and Cornelius C. Lewis.) Twenty-two seed plants of varying degrees of development were grown in soil in three series. To one series no potassium was added; to another, potassium chloride; to the third, feldspar in quantity equivalent in potassium content to the second series. At maturity the potassium content of the plants was determined by chemical analysis, and percentage gains in all series were computed.

The percentage gain of potassium from both soluble and insoluble sources tended to decrease as the plants ascend from the lower to the higher order of development.

In the control medium, plants of the lower orders showed deficiency symptoms earlier than those of the higher orders.

The lower developed plants, such as larkspur, rape, poppy, lespedeza, velvet leaf, and geranium, absorbed a larger quantity of potassium from the orthoclase feldspar than did the more highly developed plants such as lettuce, sunflowers, sage, and spinach. With few exceptions, the lower the plant in its development, the more easily it secured potassium from relatively insoluble sources.

**Magnesium Requirements of Certain Plants.** (Walter S. Eisenmenger and Karol J. Kucinski.) The need of plants for magnesium to maintain normal physiological processes is not easily determined because the amounts of the element required by different species are not the same. The magnesium requirement is higher for garden crops than for such crops as wheat, rye, or oats. Some of the hybrid varieties of corn are seemingly unable to secure sufficient magnesium from magnesium-deficient soils where open-pollinated corn may grow normally. With the exception of a few botanical families, the more highly developed plants do not show magnesium deficiency symptoms to the same degree as do the lower orders of plants. This may mean either that the lower orders of seed plants need more magnesium or that they are more sensitive to abnormal conditions.

The pH of a soil influences the degree of magnesium deficiency. On a soil which was magnesium-deficient and which had a pH of 6.8, there was less chlorosis and growth was less retarded than on a magnesium-deficient soil where the pH was 4.5. This is probably due to the more rapid washing out of the magnesium ions from the weathering rock particles under lower pH conditions. Magnesium-deficiency symptoms are not usually present where the soil has a high pH value or high organic matter content. It has been observed that magnesium deficiency in plants is associated with soils having a low base exchange capacity.

When magnesium salts are applied to a soil where annuals are grown, an increase in the magnesium content of the plant tissue is found. This is not true for all perennials. Certain species of perennials, as they grow older, seem to lose their capacity to increase their magnesium content.

**Magnesium Deficiency Investigations.** (W. S. Eisenmenger and Dale A. Hinkle.) Analyses of leaves from 18 different species of plants which were grown on magnesium-deficient and magnesium-treated plots showed that a deficiency of magnesium in the soil greatly reduced not only the chlorophyll content of leaves but also the xanthophyll and carotene content. Coefficients of correlation between the losses of any two of the three pigments were high and positive. When the chlorophyll content was used as a criterion of magnesium deficiency, it appeared that, for the most part, those plants low in the scale of evolutionary development suffered more from magnesium deficiency than plants higher up in the scale.



A greenhouse study was made to determine the effects of the cations in the alkali group of the periodic table upon the absorption of magnesium by tomatoes. Lithium at the rate of 30 parts per million proved toxic when applied to Merri-mac sandy loam. The addition of 300 parts per million of potassium, 125 parts per million of rubidium, or an equal amount of cesium had no effect on the amount of magnesium absorbed, or on the degree of chlorosis of the lower leaves as compared with a check treatment in which nothing was added. However, all these treatments, as well as the check treatment, resulted in significantly less magnesium absorption and less pigment production than a treatment in which magnesium was added. Sodium at the rate of 300 parts per million overcame magnesium deficiency to some degree as was shown by the absence of chlorosis of the leaves and a slightly higher uptake of magnesium.

Magnesium sulfate applied around apple trees at the rate of 5, 15, and 25 pounds per tree failed to increase the magnesium content of the leaves.

Yields were recorded for nine vegetable and berry crops grown on plots which were known to be deficient in magnesium. One plot was treated with magnesium alone; a second with magnesium and lime; a third with lime alone; and a fourth received neither magnesium nor lime. All plots received 1 ton per acre of 5-8-7 fertilizer especially prepared to contain no magnesium. Blueberries yielded highest where neither lime nor magnesium was added; tomatoes and eggplant, where magnesium alone was added; beets and cabbage, where magnesium and lime were added; and raspberries, peppers, string beans, and carrots, where lime alone was added.

The results of the studies on vegetables indicate the importance of magnesium in vegetable fertilizers, since a high carotene content is desirable from a nutritional standpoint.

**Tobacco Quantity and Quality Following Early Fall Application of Nitrogen Fertilizer.** (Walter S. Eisenmenger and Karol J. Kucinski.) When tobacco is grown following such crops as corn, clovers, and grasses, which are high in lignin, symptoms of brown rootrot are more likely to occur. Micro-organisms instrumental in decomposing tissues containing much lignin need an abundance of nitrogen and consequently rob the tobacco plant temporarily of this element. Nitrate of soda at the rate of 0, 50, 100, 200, 300, and 500 pounds of nitrogen per acre was applied to some hay plots in the early fall and to others in the spring before the plots were plowed. In nearly all cases, these treatments resulted in increased yields and improved quality of the tobacco grown on these plots; however, the higher rates of 300 and 500 pounds of nitrogen did not greatly increase the yield over the lower rate of 200 pounds. Those plots plowed in the early fall showed a greater response to nitrogen than those similarly treated but plowed in the spring. The micro-organisms apparently need the warmth of the early fall to act more fully on the plant tissues plowed under.

In a similar experiment where corn was plowed under, the yield and quality of the succeeding crop of tobacco was best where the corn was plowed under in the early fall.

**Chloropicrin for Tobacco Seedbed Sterilization.** (C. V. Kightlinger.) Chloropicrin has been used extensively by Massachusetts tobacco growers during the last few years to sterilize tobacco seedbeds and, in general, it has been satisfactory. However, in 1947, some seedbeds which had been sterilized with chloropicrin in the fall of 1946 were almost total failures. Some growers attributed these failures to the presence of residual chloropicrin which had not evaporated because of the low soil temperature which followed its application. Many grow-

ers are now afraid to use chloropicrin for soil sterilization and, owing to the general unavailability of steam sterilization, they have no satisfactory substitute.

The object of this experiment was to determine whether late fall sterilization of tobacco seedbed soil with chloropicrin would cause poor germination and growth of tobacco seeded the following spring. Other factors affecting the production of tobacco seedlings were also studied.

Four seedbed plots, 30 feet long and 6 feet wide, each received 25 pounds of a 8-4-8 tobacco fertilizer: two in late October, 1947, and two shortly before seeding time in the spring of 1948. One of each pair of plots was sterilized with chloropicrin in late October, 1947; the other two were not sterilized. The soil temperature of the plots was about 50° F. at the time of treatment with chloropicrin and remained low for the rest of the fall. The observed results were as follows:

*Plot I. Fall Fertilized and Sterilized.* The germination of seed was very good; the seedlings grew well and weed control was good. The productivity as well as the weed control in this plot was equal to that obtained in another seedbed which had been sterilized with chloropicrin and fertilized early in September. At that time the temperature of the soil was well above 60° F. and remained so for a considerable time.

*Plot II. Fall Fertilized but Not Sterilized.* The stand and growth of seedlings were good but not so good as on Plot I. The weed infestation was heavy.

*Plot III. Fall Sterilized and Spring Fertilized.* The stand of seedlings was very poor with no plants at all occurring in large areas. The seedlings grew poorly throughout the season. The weed control was good but less effective than on Plot I. Possibly the poor stand of tobacco seedlings offered less competition to those weeds which survived the sterilization, and thus the weeds grew more vigorously.

*Plot IV. Spring Fertilized but Not Sterilized.* The stand of tobacco seedlings and their subsequent growth was poor throughout the season. Weed infestation was heavy but somewhat less than on Plot II.

The general conclusions and practical applications of these observations are: Chloropicrin, although applied late in the season, was apparently not the cause of the seedbed failure in this trial. The failure of the seedbed was attributed to effects of the spring application of the fertilizer. It is believed that tobacco seedbeds should be fertilized in the fall or at least a considerable time before the seeding if the fertilizer is applied in the spring.

**Fertilizer Placement for Potatoes.** (C. V. Kightlinger and H. M. Yegian.) It is the purpose of this project to determine how different ways of applying fertilizer affect the growth and yield of potatoes.

Fertilizer of 5-10-10 formula was used at the rate of 2200 pounds per acre and was applied in three ways: all banded; half banded and half broadcast; and all broadcast. The broadcast fertilizer was harrowed into the soil thoroughly before the potatoes were planted. The banded fertilizer was applied in the usual manner by the potato planter.

The plots were one-twelfth acre in size and were replicated four times. Green Mountain potatoes were planted about the middle of May and were sprayed with Bordeaux mixture at weekly intervals from the middle of June until frost killed the vines in late September, with DDT and nicotine used as needed to control insects.

Plots where the fertilizer was all banded produced much better growth of vines and much larger yields of potatoes: 23 percent more marketable potatoes than the plots on which the fertilizer was half banded and half broadcast, and 51 percent more than the plots on which the fertilizer was all broadcast. Also, con-

siderably fewer B grade and cull potatoes were obtained from the plots on which the fertilizer was applied all banded than from the other plots.

**Potato Vine Lifters.** (Karol J. Kucinski.) When potato vines become large enough to cover the space between the rows, the moving of spraying equipment through the field crushes the vines, thus causing a decrease in yield. An improved vine lifter has been developed which will pick up the vines from the space between the rows and push them back into the rows. This allows the passage of the wheels of both the tractor and the sprayer without injury to the plants.

The lifters were patterned after those developed by John W. Slosser, Engineer, Research Division of the Soil Conservation Service, in cooperation with the Maine Agricultural Experiment Station. Certain modifications of the basic design were made to improve the operation and utility of the lifters.

Each lifter is attached to its control by means of a clevis and pin coupler to make its removal from the tractor easy. The vine lifters for the tractor rear wheels are suspended from the arms which usually carry the cultivators and can be operated hydraulically. The vine lifter for the front tricycle wheel is suspended by a small rope attached to the hanger rod of the lifter and through a pulley to the hand-lever used in connection with the cultivator. The two lifters for the wheels of the sprayer are suspended from an arm attached to the sprayer frame and the hand-lever is used to adjust the lifters and can be operated from the driver's seat. The lifters are made of  $\frac{3}{4}$ " steel rod and the hanger arms from  $\frac{5}{8}$ " steel rod. The lifters for the tractor would be designed as required for each make and model. The accompanying illustration shows the vine lifters attached to the sprayer and the tractor.



Simple-to-Make Potato Vine Lifter Attached to Tractor and Spray Rig.



**Tests of Spray Materials for the Control of Late Blight of Potatoes.** (C. V. Kightlinger and H. M. Yegian.) It is the object of this investigation to compare the effectiveness of some of the newer fungicides with the standard Bordeaux mixture for controlling late blight of potatoes, and to determine the effect of these materials on vine growth and production.

In 1947 the investigation was confined to the use of Bordeaux mixture, neutral copper (COCS), Dithane 14, and Dithane 278. Test plots of one-thirtieth acre were established for each kind of fungicide and for one check treatment where no fungicide was used. The plots were all replicated four times and were randomized. Green Mountain potatoes were used as the test crop and were sprayed with recommended rates of fungicide at weekly intervals from mid-June until frost killed the vines in late September. Insects were controlled as needed with sprays containing DDT and nicotine.

Late blight occurred too lightly in 1947 to make the results conclusive; however, the more evident observations can be summarized as follows:

1. Bordeaux mixture was the most effective of the fungicides tested for controlling late blight, but it caused a noticeable depression in the growth of the plants.

2. Neutral copper, Dithane 14, and Dithane 278 were about equally effective in controlling late blight, but were less efficient than the Bordeaux mixture. These materials did not depress the growth of the vines significantly.

3. With all of these fungicides, spraying at weekly intervals was not sufficient to completely control the blight during the time the plants were growing the fastest.

**Potato Variety Trials.** (Karol J. Kucinski and Ralph W. Donaldson.) Eight potato varieties commonly grown in this region have been tested annually with respect to their yielding qualities. Based on 10 to 14 year averages, the varieties rank themselves in the following order: Green Mountain, 436 bushels; Chippewa, 368; Russet Rural, 364; Houma, 342; Warba, 336; Irish Cobbler, 308; and Sebago, 305 bushels.

**Soil Conservation Research Projects.** In cooperation with the Research Division of the Soil Conservation Service, United States Department of Agriculture. (Karol J. Kucinski, Project Supervisor.)

*A Survey of Erosion Problems Arising from Changes in Soil Use.* The commercial growing of potatoes in the western foothills and plateaus of Massachusetts has become well established during the past few years. Old sod and pasture lands which have not been plowed for as many as thirty years are now being cleared and put into potato production. Since the potato fields are rather large areas located on sloping hillsides, where the season does not permit the use of winter cover crops, considerable soil erosion has taken place. Periodic analysis of the soil taken from selected areas shows that in nearly all cases the organic matter content has decreased more than 50 percent from what it was five or six years ago. The farmers realize that their soils are deteriorating rapidly, and are calling on the Soil Conservation Service "Operations" for technical aid in solving their problems of erosion and soil depletion. Contour planting, terracing, and rotation with green manure crops are the control measures recommended.

*Studies to Determine the Effects of Loss of Top Soil on Crop Yields.* In order to illustrate the value of top soil and organic matter, a field experiment was initiated, in which the top soil (to plow depth) was totally removed from a plot

while an adjacent plot was left undisturbed as a check plot. Spring wheat, white sweet clover, winter rye, and buckwheat were grown on fertilized and unfertilized portions of these two areas. The decrease in yield due to top-soil removal ranged from 63 to 81 percent for the fertilized areas and from 91 percent to complete crop failure for the unfertilized areas.

*The Investigation of Beach Grass.* The native or American beach grass (*Ammophila breviligulata*) found commonly on Cape Cod has been used successfully in the stabilization of beach areas and coastal sand dunes. A heavy type of transplanting machine which has been developed recently is capable of planting about six acres a day. The use of this machine has made it economically feasible to transplant beach grass and has created a demand for large quantities of transplanting stock. There are some indications that fertilization of natural beach grass will tend to increase the stands and thus provide more and better propagating stock per given area.

Studies are in progress to determine what response beach grass will make to fertilization and liming, in the natural state and after it has been transplanted.

*Investigations with Various Winter Cover Crops for Onion and Potato Fields in the Connecticut River Valley.* The date and rate of seeding and kind of cover crop used depend somewhat on the preceding and succeeding crop. For several years such crops as winter rye, barley, oats, buckwheat, domestic rye grass, and Italian rye grass have been seeded at weekly intervals from the beginning of September through the last week in November. Winter rye, oats, and barley produced excellent cover when they were sown in September and early October; fair to medium cover when seeded from middle to late October; and poor cover when seeded during November, especially during the last week of November, when growth was considered unsatisfactory. Not very much stooling resulted when these crops were seeded after the middle of October. Italian or domestic rye grass and buckwheat do well when seeded in early September. Rye grass, when planted early, produced a thick mass of fine roots, which may be superior to the coarse roots of the cereal plants for the prevention of water erosion. Some rye grass may survive mild winters, and this should be taken into consideration if seedings are made in fields to be used for certain crops like onions where it is not the custom to plow in the spring. Barley and oats, which winterkill yet produce a desirable protective mat cover, may be used in onions and other small-vegetable fields. The mat thus produced can be easily disked and will not interfere with the preparation of the field in the early spring. Buckwheat can be used as a green manure crop, catch crop, or cover crop, but is not satisfactory as a winter cover crop. It is killed by the first light frost, and the mat produced on the soil surface is not a sufficient protection against erosion.

The rate of seeding for oats, winter rye, and barley is  $1\frac{1}{2}$  to 2 bushels per acre, and the larger rate should be used if seeding is made during October. For Italian or domestic rye grass, when used as cover crops, 25 pounds per acre has been found to be a desirable rate of seeding, and for buckwheat about 35 to 40 pounds.

*Use of Snow Fencing in Controlling Wind Erosion.* Farmers in the Connecticut Valley have the problem of protecting their soils and crops from wind damage. The winds which occur during early spring result in losses of soil, seed, fertilizer, and young crops. This damage usually occurs at particular areas on a farm, called "blowouts." To control these local "blowout" spots temporarily until the crop has established itself, some form of windbreak may be used. Trials have shown that snow fencing is satisfactory for this purpose. The cumbersome

guy-wires generally used in connection with the fencing for protection against snow drifting are not necessary when the fencing is used for wind erosion control. Old iron pipes or wooden stakes  $4\frac{1}{2}$  to 5 feet long, driven 18 inches into the ground and spaced a rod apart, will hold the 4-foot-high lath fencing throughout the entire season. If the fencing is placed on the windward edge of the "blowout" at right angles to the prevailing winds and the crop rows are placed parallel to the fencing, very little loss of tillable area or inconvenience in operation of farm machinery will be experienced. One fence row is usually sufficient to control "blowouts" of the size commonly found in this section.

**Breeding Work with Orchard Grass.** (W. G. Colby.) This project was described in the Annual Report for 1945 (Mass. Agr. Expt. Sta. Bul. 428, p. 13). The orchard grass strain, Finnish Late Hay, has continued to give good results when grown with alfalfa or Ladino clover. The strain has received some criticism for lack of vigor. However, for growing with Ladino clover, less vigorous strains are desirable because they do not crowd out the clover two or three years after seeding; for use with alfalfa the competitive factor is not so important.

Breeding work has been progressing in an effort to select vigorous late-maturing plants, and several such plants have been isolated during the past year. Whereas commercial orchard grass reached the bloom stage by June 12, several of these late-maturing selections did not reach bloom stage until June 28. Most of the late-maturing orchard grass strains are susceptible to winter injury, especially in the seedling stage. Finnish Late Hay is as hardy as most commercial strains. Attempts to test the winter hardiness of these late-maturing selections failed last year because of the heavy ground cover of snow throughout most of the winter.

**Red Clover Variety Trials.** (W. G. Colby.) Seed for the varieties included in these trials was supplied by the U. S. D. A. Bureau of Plant Industry. Following are the varieties tested in 1947: Midland, Dollard, Ottawa, Wisconsin Mildew Resistant, Cumberland, Southern Selection, Kentucky Selection, and New Hampshire Perennial. The three southern anthracnose-resistant strains, Cumberland, Southern Selection, and Kentucky Selection, have proved to be winter hardy and have given just as good if not better performance than the best northern strains. Kentucky Selection and Southern Selection in particular were outstanding. Plots seeded in the spring of 1946 still had a 20 percent stand by the spring of 1948. Comparable plots of Midland clover, a recommended northern strain, had less than a 5 percent stand. Results thus far indicate that seed companies supplying seed of some of the anthracnose-resistant strains to southern clover-growing sections could, when seed supplies are adequate, use seed of these same varieties for northern red clover-growing sections.

**Trials with New Oat Varieties.** (W. G. Colby.) Heavy summer thunder showers caused serious lodging with all varieties included in the oat variety test carried on in cooperation with the U. S. D. A. Division of Cereal Crops. Three varieties, Ajax, Clinton, and Mohawk, although seriously lodged, nevertheless gave good yields of fair quality grain. Ajax and Clinton have been grown for several years and both varieties have been outstanding for their resistance to lodging and have also ranked high in grain yields. Mohawk was grown for the first time in 1946. Although not among the highest-yielding varieties in 1946, its stiff straw was an outstanding characteristic.



**Trials with Alfalfa Strains and Selections.** (W. G. Colby.) In the spring of 1946 an alfalfa nursery was planted which included some 60 selections and varieties of alfalfa. Standard varieties such as Kansas Common, Oklahoma Common, and Baltic, and newer varieties such as Buffalo, Ranger, and Atlantic were all grown with some 50 clonal selections from Nebraska and Kansas. Few differences have been noted in the performance of these strains. Several of the newer strains are resistant to the bacterial wilt disease but since there has been no evidence of this disease up to the present, the resistant varieties have been no better than any of the other varieties and selections. It is questionable whether a farmer in Massachusetts is justified in paying premium prices for seed of wilt-resistant varieties of alfalfa like Ranger or Buffalo unless he knows that this disease is a serious problem on his farm.

**Onion Breeding.** (Hrant M. Yegian.) The tendency to produce doubles is found in all varieties of set type onions, *Allium cepa* L. The size of the set and the environmental factors are considered to play an important part in the appearance of this undesirable character. Sets over three-quarters or one inch in diameter are more likely to produce double bulbs during favorable growing seasons than the sets under three-quarters of an inch. Some variations, however, occur in the double bulb frequencies in sets of different varieties but of the same size. This would suggest that inherent differences in susceptibility to produce doubles exist in the several varieties.

In an endeavor to obtain a further understanding of the causes of doubles in set onions, various local Ebenezer varieties were selfed and selected. In one instance a double set attached together at the base was produced from the selfed seed of one of the selections. Cases of double sets from a single seed are rare. This newly found case strongly suggests that the character of doubles in onions is probably of a genetic nature.

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## DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

**A Study of the Mineral Elements of Cows' Milk.** (J. G. Archibald.) The element nickel has been studied during the past year. Procedure has been the same as that outlined for other elements in earlier reports. Eight cows were used for the study (two each of the Ayrshire, Holstein, Guernsey, and milking Short-horn breeds); the supplement, nickel(ous) chloride, was fed at the rate of 500 milligrams (approximately 125 milligrams of elemental nickel) per cow daily. Much of the time spent on the project was devoted to perfecting a method which would detect minute traces of the element (of the order of five parts per billion or less).

The analytical work on the season's milk samples has been completed; although the trend was toward an increased amount of nickel in the milk when the cows received the supplement, the results were not uniform and not statistically significant. This is believed to be due to imperfections of method; it is therefore planned to make further study of methods and technique and to repeat the trials next year.

**A Study of Quality in Roughage: Composition, Palatability, and Nutritive Value of Hays as Affected by Curing, Harvesting, and Storing Procedures.** (J. G. Archibald, M. L. Blaisdell, and H. N. Stapleton.) Twelve lots of hay have been studied, involving the analysis of 50 samples. Nine of these lots were

from the College Farm; three from cooperating farmers. In addition to regular fodder analysis, sugar and carotene were determined in all samples. The chemical changes which take place in the hay from cutting time to feeding time (often 3 to 6 months) were followed closely for all lots of hay from the College Farm and for one lot from a farmer cooperator. Factors studied were exposure to prolonged sunlight; exposure to rain; field curing and storing as loose hay; field curing and storing as baled hay; barn drying of loose hay; and barn drying of baled hay. One feeding trial with two milking cows was conducted over a four-month period.

Action of either bright sunlight or rain for two days reduced carotene content of field-cured hay at loading time to about a third of its initial value. Sunlight, although it caused some lowering of the sugar content, had a much less adverse effect on sugar than on carotene.

Barn drying of either loose or baled hay may have possessed some initial advantage over field curing in conservation of carotene; but by the time the hay had been in storage several weeks, this advantage had largely disappeared, owing apparently to adverse storage conditions (high mow temperatures). This was also true to a lesser extent for sugar. Sugar content of some lots of hay was markedly reduced in storage, regardless of method of curing; this is thought to be due to the fact that the hay was stored too wet and/or to trouble with blower installations.

The advantages of baling and barn drying may be entirely offset by attempting to barn-dry either baled or loose hay at too high moisture levels. Tentatively 40 to 45 percent of moisture is suggested as the upper limit for safe storage over a barn dryer.

From the standpoint of carotene and sugar conservation, present methods of curing and storing hay need further study. There is some evidence to show that where a blower is operated efficiently, sugar is quite well conserved; but if farmers are interested in saving as much carotene as possible, good silage seems to be the answer in the present state of our knowledge.

The feeding trial was conducted with hay in which the sugar content had been greatly reduced (from around 6 percent to about 2 percent) by adverse curing conditions. When this hay was supplemented with sufficient crude glucose syrup to bring the total sugar intake back to normal, the cows produced 1.1 pounds more milk (4%—F.C.M.) daily than when the supplemental sugar was withheld. Shrinkage in milk flow from month to month was 1.6 percent when the syrup was fed and 7.8 percent when it was withheld. Whether this favorable result was a specific effect of the added sugar, or whether it simply represented a response to increased intake of total digestible nutrients is not known. Further light on the question will be sought this coming season by using a larger number of cows in a comparison of two kinds of hay, similar in character, except that one will have normal sugar content, while the other will be designedly low in sugar.

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## DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

**Survival of *Escherichia coli* from Sewage in Soil of a Septic Tank Disposal Field.** (James E. Fuller.) This study was prompted by the failure to recover *Escherichia coli* from the soil of the disposal fields of an experimental septic tank installation (Mass. Expt. Sta. Bul. 441, p. 17, 1947). In the present project pure cultures of *E. coli* are being inoculated into soils, both sterilized and non-

sterilized, and their survival in the soils is determined by accepted cultural procedures. The work is still in a preliminary stage, but results indicate that the organism survives for only a few weeks under optimum conditions of moisture and temperature. The results of the study reported in Bul. 441, and of an earlier one (Study of septic tank efficiency, Mass. Expt. Sta. Bul. 436, p. 17, 1946), have been published as a Station bulletin (Mass. Expt. Sta. Bul. 446).

**Bacteriological Study of Sewage Sludge.** (James E. Fuller.) Previous experience in this laboratory had shown that *Escherichia coli* from sewage disappears in a comparatively short time when sludge from a sewage disposal plant is put onto a sand filter bed. The present study was undertaken to determine the reasons for this disappearance and thus to provide some basic information concerning the physiology of *E. coli* and its relation to its environment. The results will be correlated with those obtained from the study of the soils of septic tank disposal fields.

To date two possible causes have been considered that might be responsible for the disappearance of *E. coli* from sludge. The first was the presence of some antagonistic biological factor such as bacteriophage or antibiotic substances produced by associated microorganisms in sludge. Results failed to indicate any such factor. The other possibility was that other microorganisms might offer competition, especially for nutriment, with which *E. coli* cannot compete successfully in sludge. *E. coli* is a normal inhabitant of the human intestine where it has optimum temperature and easily utilizable simple organic sources of carbon and nitrogen. When sludge was placed on a sand filter in the laboratory and held at room temperature, *E. coli* disappeared after 14 days, while *Aerobacter aerogenes* and other soil types of *coliform bacteria* persisted. At body temperature (37° C.), *E. coli* survived up to 56 days, and *A. aerogenes* survived much longer. This suggested a temperature influence, since *E. coli* is accustomed to the temperature of the human body. When organic food substances (dextrose and peptone) were added to sludge, *E. coli* survived for 21 days, whereas it had disappeared in 14 days without the added nutriment. Sludge, from which *E. coli* had disappeared, was sterilized in an autoclave to destroy competing microorganisms. *E. coli* was inoculated into the sterile sludge and has survived for 42 days. These results all favor the competition theory as an explanation of the disappearance of *E. coli* from sludge.

**Effect of Volatile Disinfectants on Survival of Microflora in Soil.** (Charles Hurwitz and Frank H. Dalton.) These studies were undertaken to provide a method for sterilizing soil for laboratory studies which would permit subsequent removal of the sterilizing agent and would cause a minimum of change in the soil itself. A sealed jar containing the soil sample was evacuated and the atmosphere saturated with one of the following volatile disinfectants: chloroform, hydrogen cyanide, chloropicrin, formaldehyde, and ethylene oxide. The rate of survival of the soil microflora was determined by plate counts and by broth-culture inoculation techniques. Ethylene oxide sterilized the soil after 11 hours exposure, formaldehyde after 3 days, and chloropicrin after 8 days. Hydrogen cyanide and chloroform decreased the numbers of viable microorganisms but did not sterilize the soil after 8 days exposure.

The extractability of copper and manganese from the soil with ammonium acetate was used as an indication of changes brought about in the soil as a result of exposure to the disinfectants. Contact of the soil with formaldehyde caused a 187 percent increase in extractable copper. With ethylene oxide the increase was 309 percent; and with chloropicrin, 444 percent. Extractable manganese



increased from 0.14 p.p.m. in the untreated soil to 2.5 p.p.m. in the soil treated with ethylene oxide, 7.7 p.p.m. in the soil treated with formaldehyde, and 21.7 p.p.m. in the soil treated with chloropicrin.

It is interesting to note that the use of formaldehyde and chloropicrin resulted in possibly toxic concentrations of manganese. These two fumigants are widely used in seedbed preparation.

Two papers entitled "Effect of volatile disinfectants on survival of microflora in soil" and "The effect of sterilization of soil upon the solubility of soil copper and manganese" have been submitted to Soil Science and Florists' Exchange, respectively, for publication.

**Microbiological Fixation of Copper in Soil.** (Charles Hurwitz.) This is a continuation of work previously reported (Mass. Expt. Sta. Bul. 441, p. 15, 1947). In attempting to determine the form of copper whose solubility was affected by unknown components of oat straw and alfalfa meal, it was found that the solubility of copper sulfide and copper phosphate, two prevalent forms of insoluble copper salts, was not increased by the soluble components of the crop residues. It is therefore inferred that the metallo-organic salts of copper, and not the inorganic salts, are the forms affected. Two papers have been published: "Extraction of copper from soil as affected by soluble components of oat straw and alfalfa meal," Soil Science Vol. 65, No. 3, March, 1948; and "Effect of decomposition of added oat straw and alfalfa meal on solubility of soil copper in ammonium acetate," Proceedings of the Soil Science Society of America, 1947.

**Effect of Decomposition of Plant Residues on the Solubility of Soil Manganese.** (Charles Hurwitz.) The results, entitled "Effect of temperature of incubation of amended soil on exchangeable manganese", have been submitted to Soil Science for publication. The effect of the temperature of decomposition of oat straw and alfalfa meal on the solubility of soil manganese in Merrimac sandy loam was studied at 4° C., 14° C., 31° C., 37° C., and 47° C. Neither water-soluble nor easily reducible soil manganese was affected, but ammonium acetate-soluble manganese showed marked variations. Little change was observed at 4° C. and 14° C., but above 30° C. the ammonium acetate-soluble manganese increased as a logarithmic function of the temperature of incubation. After further incubation, the exchangeable manganese decreased to initial levels. There was a tendency for the increase to be maintained over a longer period at the higher incubation temperatures. Glucose and peptone, when added to soil instead of oat straw and alfalfa meal, also increased the ammonium acetate-soluble manganese, both the increase and subsequent decrease being more rapid. When no organic matter was added to the soil, no increase in soluble manganese was observed from 4° C. through 37° C. At 47° C. a slight but significant increase was observed.

These findings may prove important in the management of greenhouse and seed-bed soils where steam sterilization is used. Toxic concentrations of manganese may result from the sterilization temperatures. Oxidation of these toxic concentrations to insoluble forms may be delayed or may not occur because of the destruction of the manganese-oxidizing bacteria by heat.

## DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

Diseases of Trees in Massachusetts. (M. A. McKenzie, A. Vincent Osmun and D. H. Marsden.)

*The Dutch Elm Disease Problem.* The first discovery of the Dutch elm disease in Massachusetts was in 1941, when a tree in Alford, Berkshire County, was found to be infected by the causal fungus, *Ceratostomella ulmi* (Schwarz) Buisman. As of July 6, 1948, the disease fungus has been isolated from 1422 elm trees of 94 municipalities in 11 counties on the mainland of Massachusetts; Barnstable, Dukes, and Nantucket being reported as disease-free at present. Those towns with a relatively large population of weed elm trees are confronted with a difficult disease control problem; but where the number of elms is more restricted and the trees have received the care given valued trees, practical disease control should be possible. Three distinct zones of build-up in disease are apparent in the State. From the original outbreak, the disease has spread rather widely in Berkshire County. In the Connecticut Valley region, the increase in the number of diseased trees has been conspicuous in the last three years; and more recently in eastern Massachusetts, elms in the vicinity of Boston have been seriously affected. The spread of the disease from year to year is shown by the following table:

Year	Cumulative Totals		
	Trees	Towns	Counties
1941.....	1	1	1
1942.....	7	5	2
1943.....	11	6	2
1944.....	43	15	2
1945.....	85	24	3
1946.....	381	47	8
1947.....	1052	68	11
1948 (July 6).....	1422	94	11

In studies to determine the spread, build-up, and possible benefits of combative measures, laboratory diagnosis of specimens is required for accurate determination of the causal fungus. The specimens are collected by scouts trained in the detection of characteristic symptoms on trees suspected of the disease. Diseased trees are reported to the Massachusetts Department of Agriculture and that Department carries out a cooperative disease control program with municipal governments or agencies responsible for affected trees. In a prepared schedule sanitation and other measures designed to restrict the spread of the disease are outlined for varying local conditions. These measures are presently under further study, including experiments in cooperation with the Department of Entomology on the use of spray materials for the control of bark beetles which serve as vectors of the disease fungus.

In general, the rate of increase in the number of diseased trees reported is most conspicuous in those areas where suppressive measures are lacking, poorly timed, or misapplied. Delay in the application of disease restrictive measures is costly, and expected benefits may be tragically nullified if essential work awaits a convenient assignment.

Thirteen progress reports (mimeographed) and six press releases were sent out during the year.

*Cytospora Disease of Spruces.* A common malady of ornamental spruces is a canker disease which attacks twigs and branches. In previous reports the cause of the disease was identified tentatively as the fungus *Cytospora Kunzei* Sacc. Lacking the identification of the causal fungus in its perfect stage on spruce, the disease was called, commonly, the "Cytospora disease" or "Cytospora canker."

In April 1947, a fungus identified as *Valsa Kunzei* Fr. was found associated with cankers on twigs and branches of Norway spruce and Colorado blue spruce. This fungus, believed to be the perfect stage of the aforementioned *Cytospora*, was described in detail, and a study was made of the growth and appearance on artificial culture media and on sterilized host tissue. Inoculations on young Norway spruce trees with *Valsa Kunzei* resulted in cankers and the death of some of the inoculated branches.

The *Valsa* stage may be involved in the natural spread of the disease by means of wind-blown ascospores, and further investigations into that possibility are needed. Also, a more intimate knowledge of factors predisposing spruces to the disease and avenues of host infection by the fungus are to be desired as prerequisites to an attempt to achieve effective control.

*Other Tree Problems.* Forty-eight diseases of twenty-three species of trees, including seven diseases of elm, were identified from more than 1500 specimens and inquiries received during the year. The *Cephalosporium* wilt of elm was reported from one additional municipality in the State. *Verticillium* sp. was isolated from several species of woody plants.

Winter injury to trees and to evergreens in particular was extensive this year. Later, during the extended period of wet weather at the time tender foliage was developing, conditions were ideal for infection of leaves by fungi. Elms, maples, sycamores, oaks, and ashes were among trees on which foliage was seriously affected and partially lost in early summer because of leaf diseases. Also, heavy infection of leaves by the black spot fungus indicates that additional loss of elm leaves may be expected by midsummer.

Two other tree disease problems have occasioned increasing numbers of inquiries in recent years. The death of individual branches and limbs in maples, leaving characteristic reddened or bronzed flags presents a problem which calls for study; and the dying of oaks lacks specific explanation. In limited studies, a combination of circumstances, including the preliminary weakening of the oaks by the defoliating gypsy moth, appears to be a logical explanation of the heavy mortality among these trees.

**Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment.** (W. L. Doran.) Work was continued on the effects of fungicides applied as powder-dips to cuttings immediately after treatment with a root-inducing substance, usually indolebutyric acid, applied by the solution-immersion method.

The following fungicides thus used were harmless to the cuttings of these species: Spergon (tetrachloro-parabenzquinone) with Canada hemlock, *Genista pilosa*, and *Juniperus squamata* Meyer; Phygon (2, 3-dichloro-1, 4 naphthoquinone) with Canada hemlock and *Genista pilosa*; morpholine thiuram disulfide with Carolina hemlock; zinc ethylene bisdithiocarbamate with red cedar; and a zinc dimethyl dithiocarbamate-cyclohexamine with Chinese juniper.



The use of the following fungicides similarly applied was followed by poorer rooting or apparent injury in the case of cuttings of these species: Arasan (tetramethyl thiuram disulfide) with Canada hemlock, heather, and *Genista pilosa*; Semesan Jr. (1.0% ethyl mercury phosphate) with Canada hemlock, Carolina hemlock and *Pachistima Canbyi*; Puraturf (6.0% phenyl mercury triethanol ammonium lactate) with Canada hemlock and creeping juniper; 2 percent Ceresan (2.0% ethyl mercury chloride) with Carolina hemlock and *Pachistima Canbyi*; zinc trichlorophenate with red cedar and *Pachistima Canbyi*; Fermate (ferric dimethyl dithiocarbamate) with heather.

It should be noted that here and throughout the report on this project better rooting means rooting in larger percentages or in a shorter time or with a larger root system.

In cooperation with Dr. Malcolm A. McKenzie of this Department, work was begun on the vegetative propagation of an elm, the Christine Buisman variety of *Ulmus carpinifolia*, which has been found to be resistant to the Dutch elm disease. Not more than 54 percent of the root-cuttings taken in early December lived more than 24 weeks after their insertion in sand, with proximal ends exposed, in a greenhouse bench; and the average length of the top growth made meanwhile was 4.5 inches. Root-cuttings taken in early March and similarly handled made root and top growth much more rapidly, with 95 percent of them living and rooted at the end of 59 days; and the average length of the top growth made meanwhile was 9.0 inches. Early March root-cuttings which were wholly covered, both distal and proximal ends under the sand, gave very inferior results.

Talc was compared with activated charcoal as a carrier of indolebutyric acid or naphthaleneacetic acid applied to cuttings by the powder-dip method. Talc so used gave better results than the charcoal with cuttings of English ivy, Hinoki cypress, bearberry, *Pyracantha coccinea*, *Ilex crenata*, *Picea glauca* and *Berberis Sargentiana*.

Taken in October, cuttings of American holly rooted equally well in sand and in flue-ash, but there was a better survival of cuttings of hemlock in sand than in flue-ash.

December cuttings of Canada hemlock rooted in larger percentages if made of wood in its first or second year rather than of wood in its third year. The rooting of cuttings of Carolina hemlock was much improved by indolebutyric acid 200 mg./l., 23 hours.

Cuttings of sugar maple rooted fairly well if taken in June and treated with indolebutyric acid but there was a high mortality among the rooted cuttings during the following winter in the greenhouse. Rooting of November cuttings of *Berberis Sargentiana* was hastened by indolebutyric acid 6 or 12 mg./gm. talc. Cuttings of *Rhododendron calendulaceum* taken in June rooted poorly without treatment, very well after instantaneous-dip treatment with indolebutyric acid 5 mg./cc.

Two papers were written and published.<sup>1</sup>

**Diseases of Plants Caused by Soil-Infesting Organisms, with Particular Attention to Control Measures.** (W. L. Doran.) Fungicides were applied to soils in a carrier of commercial fertilizer (usually a 5-8-7 formula at the rate of 15.6 grams per square foot of soil surface) immediately before seeding. Their effects on the damping-off of several vegetables, on smut of onion (caused by

<sup>1</sup>Doran, W. L. and Beaumont, A. B. Vegetative propagation of kudzu. Jour. Amer. Soc. Agron. 39:9:834-835. 1947 (Mass. Agr. Expt. Sta. Contrib. No. 625).

Doran, W. L. Get out your knife and see how you can multiply. Horticulture 25:16:447, 461. 1947.

*Urocystis cepulae* Frost), on clubroot of cabbage (caused by *Plasmidiophora brassicae* Wor.), and on growth of plants are here summarized. Rates of application of the fungicides are in all cases expressed as grams per square foot, 1.0 gram per square foot being about 96 pounds per acre. None of the materials were injurious to plants unless it is so stated, and their use was often followed by an increase in average green weights of seedlings.

The result of the control of pre- and post-emergence damping-off is expressed as the percentage increase in number of living seedlings, the basis of comparison being the numbers of plants which lived in untreated soil. Numbers of living cabbage seedlings were increased 633 percent by Phygon (2, 3-dichloro-1, 4 naphthoquinone) 0.65 gm.; less by Arasan similarly used; and 377 percent in one case, 889 percent in another, by Tuads (tetramethyl thiuram disulfide) 0.65 gm. Increase in weight of cabbage seedlings was 86 percent with Phygon, 50 percent with Tuads. Numbers of tomato seedlings which lived were increased 281 percent by Tuads 0.65 gm., 246 by Phygon 0.65 gm. Increases in average green weights of the seedlings were 183 and 233 percent, respectively. The use of Tuads 0.65 gm. was followed by an increase of 35 percent in the number of living beet seedlings and 82 percent in the number of living lettuce seedlings.

With more than 50 percent of the onion seedlings infected with smut in untreated soil, Tuads 0.65 gm., Phygon 0.65 gm., or Fermate (ferric dimethyl dithio-carbamate) prevented all smut. Since Tuads and Phygon gave better control of damping-off than Fermate, larger numbers of plants survived, the increase over numbers surviving in untreated soil being more than 1000 percent with both materials. However, Phygon sometimes retarded the growth of onion seedlings slightly, so Tuads or Arasan (another tetramethyl thiuram disulfide product) is probably to be preferred. When 50 percent of the onion seedlings in untreated soil were infected with smut, there was no smut with Arasan 0.6 gm. and, as a result of good control of damping-off, numbers of living plants were greater by more than 2000 percent.

The organic fungicides used gave some degree of protection against clubroot of cabbage when it was not too severe in untreated soil, and the abstract of a paper on this phase of the subject has been published.<sup>1</sup> But with 100 percent severe infection in untreated and heavily watered soil, there was poor or little control of clubroot by Arasan 0.7 gm., Phygon 0.7 gm., Tuads 0.65 gm., or a zinc dimethyl dithiocarbamate-cyclohexylamine complex 2.0 gm.

With clubroot of cabbage severe, 100 percent infection in untreated soil, there was also 100 percent infection in soil to which hydrated lime 20 gm. had been applied and in soil to which mercurous chloride 0.2 gm., but no lime, had been applied. But when hydrated lime 20 gm. and mercurous chloride 0.2 gm. were applied together to this soil, there was only 13 percent clubroot, the degree of infection was slight, and the average green weight of the plants was 128 percent greater than in untreated soil. Mercurous chloride 0.2 gm. or mercuric chloride 0.1 gm. retarded the early growth of cabbage if applied to *unlimed* soil immediately before seeding, but not if applied to soil limed as described above. (This was true also of their effect on onion seedlings.) Neither of these mercury salts was injurious to cabbage plants if applied to soil 22 days before seeding.

The effect of soil-moisture content on the control of clubroot is now under investigation, with soil watered daily to 50, 65, and 80 percent of its water-holding capacity. Thirty-six days after seeding, there was 100 percent clubroot in the wettest soil, 56 percent in the soil 65 percent saturated, 10 percent in the driest

<sup>1</sup>Doran, W. L. Fungicides applied in fertilizers for the control of cabbage clubroot and damping-off. (Abst.) *Phytopathology* 37:11:848. 1947.

soil, and no clubroot at any soil-moisture content in soil treated with both hydrated lime 20 gm. and mercurous chloride 0.2 gm.

**Tobacco Frenching.** (L. H. Jones.) Research this past year has been concerned with the effect of partial sterilization of the soil on the elimination of the frenching factor; with the control of frenching by adding iron to the soil and its relation to iron content of the foliage; and with the symptoms of frenching induced by nitrogen deficiency and soil temperature, separately or combined.

A compost soil was divided into four fractions for treatment by autoclaving, air-drying, or formaldehyde, with one portion left untreated as a check. Both soil temperatures, high 95° F. and low 70° F., were used. Nitrogen was frequently added to the soil and the diphenylamine test on the foliage always showed nitrates present in the plants. No frenching occurred at the low soil temperature of 70° F. or on the plants in the autoclaved soil at 95° F. Air-drying of the soil did not prevent frenching in this experiment although it had been effective in previous experiments. Formaldehyde was not a preventive, although the soil had been treated with four times the amount usually recommended.

That the organism, or frenching factor, does not enter the soil through fresh cow manure is indicated by the results of an experiment in which manure was mixed with autoclaved soil and the plants grown at 95° F. No frenching occurred. Frenching did occur when the manure was mixed with non-autoclaved soil and in the check soil receiving no manure. The nitrogen content of the plants was high in all tests.

Freezing the soil does not eliminate the frenching agent. Immediately after thawing, soil from a pile subjected to freezing all winter produced frenched plants in 7 days, whereas soil protected against freezing required 10 to 13 days.

Chemical analysis for iron in the above-ground portion of Havana Seed tobacco plants indicated a relationship between iron content of the plants and frenching. The iron content was much lower in plants grown at a soil temperature of 95° F., which frenched, than in plants grown at a soil temperature of 70°, which did not french. However, when the soil was autoclaved before the plants were set, no frenching occurred at 95°, and the iron content of the plants was even higher than that of plants in autoclaved soil at 70°.

The addition of a ferrous sulfate-peat mixture prevented frenching and gave the plants a very high iron content. However, when the iron was supplied from the less available iron of ferric phosphate mixed with peat, frenching was not prevented by three lessening amounts and the iron content of the plants was no greater than that of plants grown in soil to which no iron was added. The heaviest application, however, did prevent frenching and the plants were higher in iron content, containing an amount similar to that found in plants growing in autoclaved soil where frenching did not take place.

It has been reported frequently that frenching is due to nitrogen deficiency. During the year it has been established that the early symptoms of frenching, pinhead mottling, induced either by high soil-temperature or by nitrogen deficiency are so nearly alike that the one cannot be distinguished from the other by general observation. Study of the various steps in the onset of the disease has shown that the pinhead mottling induced by high soil-temperature appears at the tip of a young leaf, earlier leaves being a dark healthy green; while pinhead mottling due to nitrogen deficiency appears first on the side near the margin of a yellow-green leaf, stunted by lack of nitrogen, the earlier leaves being quite yellow and even fired. Succeeding leaves in both instances are so nearly alike that, unless on the plant, the cause would be sheer guesswork. Sometimes it is possible to use the diphenylamine test to distinguish the cause.



Both causes produce chlorotic, narrowing leaves, even to filiform. Rosetting also occurs. Frenching from high soil-temperature is usually obtainable within 20 days and has been obtained in as little as 5 days. In these experiments, the shortest time in which pinhead mottling was obtained from a nitrogen-deficient soil was 38 days.

Plants with frenching due to nitrogen deficiency have always resumed normal growth after the application of nitrogenous material to the soil, but affected leaves did not completely recover. Frenched plants resulting from a high soil-temperature do not respond to applications of nitrogen, but resume normal growth if the soil moisture is reduced so that the plants wilt, or if the soil temperature is reduced to about 70° F. Frenched plants with chlorotic leaves due to nitrogen deficiency remain chlorotic till nitrogen is supplied. On the other hand, the chlorosis resulting from a high soil-temperature frequently disappears and newly developing frenched leaves, even the filiform type, may develop with a normal green color.

The theory that a lack of available iron is the cause of the type of frenching induced by a high soil-temperature is further substantiated by an experience with chlorotic rose plants in a greenhouse. The temperature in the greenhouse was high (August). A manure mulch supplied ample nitrogen, which was verified by the diphenylamine test on foliage tissue. An application of a mixture of iron sulfate (copperas) and peat followed by a heavy watering brought recovery to the plants. Discs made from the chlorotic leaves and floated on a solution of ferrous sulfate (Fe 6 p.p.m.) recovered a normal green color, while the checks remained chlorotic.

**Tomato Leaf Mold Caused by the Fungus *Cladosporium fulvum* Cke.** (E. F. Guba, Waltham.) All the effort since the last report has been concerned with the further improvement of Improved Bay State tomato with respect to quality and yield of fruit and resistance to leaf mold. This tomato is essentially similar to the Bay State tomato described in Massachusetts Agricultural Experiment Station Bulletin 393, 1942, with the factor for resistance to all forms of the fungus *Cladosporium fulvum* Cke. added. The variant of the pathogene to which Bay State, Globelle, Vetomold-121, and Vetomold are highly susceptible does not trouble Improved Bay State, which is resistant to all forms of the pathogene and has been reported to be highly resistant wherever in the world it has been grown. This tomato is grown extensively under glass in Ontario, New York, Nova Scotia, and the New England States, and the financial benefit to growers has been great.

Similar resistance to *Cladosporium* has been bred into several English forcing tomatoes such as Carter's Sunrise, Kondine Red, Hundredfold, Best-of-All, and Market King. The study of these hybrids is in progress in the desire to develop a range of commercially acceptable resistant types.

**Search for Inherent Resistance to Tomato Late Blight Fungus.** (E. F. Guba, Waltham.) Approximately 200 types of tomatoes have been tested for their behavior to the late blight fungus, *Phytophthora infestans* (Mont.) de Bary. The tomatoes were grown to maturity in the field in the summer of 1947, but because of unfavorable weather conditions for the fungus it was not possible to promote the disease.

Growth and fruiting habits of the plants were recorded. Epidemic conditions for the fungus were established among stands of seedlings of these tomatoes in the greenhouse in the early season of 1948. Included in these tests were *Lycopersicon esculentum*, *pimpinellifolium*, *hirsutum*, *peruvianum*, and numerous plum, cherry, and currant fruiting types in red, orange, and yellow colors and plant

growth varying from extremely prostrate to erect. Most of these tomatoes are primitive and were obtained either directly from South America or through the Office of Foreign Plant Introduction, U. S. Department of Agriculture. From duplicated tests in the greenhouse, some promising types immune to the late blight fungus have been found. These represent survivals in the presence of complete devastation of the rest of the planting from the disease. These plants are being grown for seed and further study before undertaking a contemplated breeding program.

**Causes and Control of Decay of Squash in Storage.** (E. F. Guba, Waltham.) The objective was to learn the value of fungicidal protectant treatments in the field in relation to squash keeping. A field of squash was maintained and sprayed during the summer months. In addition, the squash were immersed in fungicides after harvest and checked periodically for infection during the winter storage season. Careful records of yields and disease were maintained.

Black Rot, caused by the fungus *Mycosphaerella citrullina* (C.O.Sm.) Gross, was unusually destructive on Butternut and Hubbard squash. Unusually warm weather up to December was an important factor contributing to the losses in storage. In the field the disease was best controlled with Fermate which yielded 3.2 percent infected squash; Parzate, 2.8 percent; and Zerlate, 1.7 percent. Unsprayed plots averaged 31 percent infected squash.

The successful control of Black Rot of Butternut squash in storage requires protectant spraying with fungicides in the field. Dipping the squash at harvest in Parzate, Phygon, or Zerlate suspensions controlled Black Rot well only when the squash had been sprayed in the field. When the stem end was removed, stem end infection was as prevalent as side infection. When the stems were retained, there was less disease at the stem end than on the sides. Painting the stem end with Phygon or Zerlate greatly reduced stem end infection, especially among squash from plots sprayed with fungicides in the field. The results show the possibilities of reducing Black Rot in storage by protectant field spraying and disinfestation of the squash with fungicides prior to storage.

**Resistance to *Fusarium dianthi* Prill et Del., the Cause of a Serious Carnation Wilt Disease.** (E. F. Guba, Waltham.) Considerable hybridizing has been done, and seedlings have been grown from successful crosses. Some 75 promising seedlings have been propagated from cuttings during the winter of 1947-48. These have been placed with two growers, recommended by the New England Carnation Growers Association, for further judging, and any that are acceptable will be subjected to tests to determine their reaction to disease, and notably to *Fusarium* Branch Rot.

**Investigations of Fungicides which Promise Value in Apple Disease Control.** (E. F. Guba, Waltham.) The objective implied by the original title of this project, i.e. "Interrelation of Wettable Sulfur, Lead Arsenate and Lime in Apple Spraying", has been attained. Project now is designed to acquaint growers with the advantages and limitations of new materials as protectants and eradicants for scab.

Lime or clay appeared to depreciate the fungicidal value of Puratized Agricultural Spray. Fermate or high grade wettable sulfur added to Puratized Agricultural Spray can be beneficial. Both Phygon and Flotation Sulfur Paste gave excellent scab control. Phygon causes a serious chlorosis of the foliage which appears to be corrected satisfactorily by the addition of twice as much Epsom salt. Epsom salt added to the spray produced darker green foliage.

The eradication of scab with Puratized Agricultural Spray was again incomplete in 1947 and 1948. Used as a protectant spray, it has given very good scab control on McIntosh trees. The fungicidal action of this spray residue deposited on glass slides is lost after 24 to 48 hours, indicating decomposition and the volatile nature of the active principle.

Scab eradication in 1948 was outstanding and striking with phenyl-mercuri acetate (Fungicide No. H L 331, California Spray Chemical Corp.); phenyl mercuri monoethanol ammonium acetate (Puratized B); and phenyl mercuri formamide (Puratized 806) (Gallowhur Chemical Corp.). The striking fungicidal action of these mercury sprays upon visible and incubating scab infection suggests that satisfactory control of this disease is possible with a belated and curtailed schedule of applications.

#### Miscellaneous Studies. (E. F. Guba, Waltham.)

*Control of Seed Decay and Damping-off of Vegetable Seedlings by Seed-borne Chemicals.* The tests of this year have concluded the effort to determine the best chemicals for the various kinds of vegetable seeds. Cuprous oxide, Semesan, Arasan, Spergon, and Phygon have general use; and Semesan, Jr., Fermate, and Zinc Oxide, special and limited application. Information is offered to the vegetable industry in the Vegetable Seed Treatment Chart published by the Extension Service of the University.

*Contact Dermatitis Among Celery Farmers.* Coincident with the introduction of green Summer Pascal celery, many farmers have complained about dermatitis on the hands and forearms from contact with this celery. Sensitive workers develop dermatitis especially while harvesting and stripping celery in the field, and contact with rotted and ripe celery is especially hazardous. Spoilage of celery in the field is due to the bacterial soft rot organism *Erwinia carotovorus*. On an average, one-third of the white workers are infected. Colored workers from the Bahama Islands and Jamaica are not sensitive. Numerous celery growers were tested for sensitivity with healthy and rotted celery tissue, with dextro-limonene oil extract of healthy stalks and leaves taken up in 9 parts of persic acid, and with crude oil from stalks and leaves without dilution. Workers sensitive to celery dermatitis in experimental tests gave positive reactions as indicated by erythema, pruritis, ulceration, vesicles, induration, and maculopapular lesions. The injurious factor is ascribed to dextro-limonene, the oil in the celery.

This study was conducted in cooperation with Dr. John G. Wiswell, Dr. John W. Erwin, Dr. Francis W. Rackemann, and Miss Lena L. Neri of the Massachusetts General Hospital, Boston. Some phases of the study require further research for completeness.

A report of the study has been accepted for publication by the American Journal of Allergy.

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#### DEPARTMENT OF CHEMISTRY

• Walter S. Ritchie in Charge

*Factors Affecting the Vitamin Content of Milk and Milk Products.* (Arthur D. Holmes.) The two types of milk, cows' and mares', used in the four studies that were completed during the past year were produced on the University farm under normal conditions. With one exception, i.e., milk from a Palomino mare, all the mares' milk was obtained from young Percheron mares. The cows' milk



was mixed herd milk produced by the five dairy breeds of cows included in the University herd.

*Composition of Mares' Milk as Compared with that of Other Species.* (Arthur D. Holmes, Albert F. Spelman, C. Tyson Smith, and John W. Kuzmeski.) The mares' milk used in this study was produced by a Palomino and four Percheron mares. All were mature, well-developed, normal animals, four to ten years old, and in their first or fifth lactations. The study was made in the spring and 26 samples of milk were assayed. The average values obtained for the milk of Percheron mares were: water 89.7 percent; protein 2.3 percent; reduced ascorbic acid 89 mg. per liter; phosphorus 63 mg., potassium 64 mg., magnesium 9.0 mg., and calcium 102 mg. per 100 g. These values indicate that mares' milk contains more water than cow, goat, ewe, buffalo, camel, or human milk; less protein than cow, goat, ewe, buffalo, or camel milk, but more than human milk; more ascorbic acid than cow, goat, or human milk; less phosphorus than cow or goat milk but more than human milk; only about one-third as much potassium as cow or goat milk; and less magnesium and calcium than cow or goat milk, but four times as much calcium as human milk. The ratio of calcium and phosphorus is considerably higher in mares' milk than in cows' or goats' milk but possibly lower than in human milk.

Apparently this paper was of service to people in widespread areas, for the numerous requests for reprints rapidly exhausted the available supply.

*Stability of Reduced Ascorbic Acid in Mares' Milk.* (Arthur D. Holmes and Carleton P. Jones.) The milk was produced by mature Percheron mares at the end of the lactation period. The samples were collected late in the fall and pastures provided nearly all of the forage for the mares, but since the season was warm and sunny, the rainfall ample, and the pasture had been closely grazed, the grass was young and green.

Fifteen samples of mares' milk with initial potencies of from 86 to 161 mg. of reduced ascorbic acid per liter were stored in the dark at 10°C. They were assayed at daily or longer intervals. Four samples observed for 10 days lost an average of 2.5 mg. per liter daily; four samples stored 20 days lost 1.8 mg. per day; two stored 28 days lost 1.3 mg. daily; and three stored for 33 days lost 1.1 mg. per liter per day. These data show that the rate of loss of reduced ascorbic acid from mares' milk is only a fraction of the rate of loss from cows' milk.

*Some Characteristics of Mares' Colostrum and Milk.* (Arthur D. Holmes and Harry G. Lindquist). Assays were made daily of the colostrum and early lactation milk produced by one Palomino and three Percheron mares. The experimental period was of fifteen days' duration for the Palomino and twenty-one days for the Percherons. The pH value of the colostrum was very stable for the first four days; on the fifth day it was decidedly higher; and from the fifth to the twenty-first days it was quite constant. The fat content of the colostrum averaged 2.5 percent for the first four days of lactation; from the fifth day it decreased slowly during the remainder of the experimental period. The quantity of total solids in the colostrum decreased very rapidly during the first two days and thereafter decreased slowly. The reduced ascorbic acid was relatively low in the colostrum but increased fairly steadily from the first to the sixteenth day of lactation and then decreased somewhat. At the first estrual period, which ordinarily occurs about nine days postpartum, both the fat and ascorbic acid content of the milk changed from the values obtained before or after the estrual period. All the mares were bred at the first estrus. The foals of the two mares that were bred late in the estrual period developed diarrhea, a condition which is not uncommon for the first postpartum estrus of mares.

*Permanency of Synthetic Ascorbic Acid Added to Milk.* (Arthur D. Holmes and Carleton P. Jones.) In a study of the stability of ascorbic acid in mares' milk, Holmes and Jones found the rate of disappearance of ascorbic acid from mares' milk was only about one-seventh that reported by Hand for cows' milk. Mares' milk contains several times as much ascorbic acid as is found in cows' milk. Accordingly a study was made of the rate of loss of reduced ascorbic acid from cows' milk to which a sufficient amount of synthetic ascorbic acid had been added so that the ascorbic acid content of the milk approximated that of mares' milk.

Two series of 20 samples each were prepared by adding 75 mg. or 150 mg. of ascorbic acid to a liter of raw cow's milk. The samples were stored in 500-cc. flasks in the dark at 10°C. As aliquots were removed day by day for analysis, the volume of milk decreased and the volume of air in the flasks increased correspondingly. For the series of samples of milk to which 75 mg. of ascorbic acid per l. was added, the loss was 11 percent per day for the first 3 days and 5 percent per day for the remaining 7 days, or 7 percent per day for the entire period. For the series of samples of milk to which 150 mg. of ascorbic acid per l. was added, the loss was 6 percent per day for the first 4 days and 1 percent per day for the remaining 6 days, or an average of 3 percent per day for the 10 days of storage.

*A Study of the Changes in Vitamin Content Coincident with Different Stages and Rates of Maturity of Vegetables Used for Home Consumption.* (Arthur D. Holmes.) The investigations conducted on this project during the past fiscal year were confined to two vegetables, tomatoes and squashes, that were grown on the University farm under controlled experimental conditions. Assays were made of typical specimens to determine the extent that cultural conditions or varieties affected the nutritive value of the vegetables under investigation.

*Variation in Composition of Winter Squashes.* (Arthur D. Holmes, C. Tyson Smith, and William H. Lachman.) Assays of the edible portion of five varieties of squash commonly used in this area as a winter vegetable showed considerable variation. Blue Hubbard was not as rich in carotene, phosphorus, and potassium as Butternut and Golden Cushaw, which are relatively new varieties that are gaining popularity. The Buttercup squash, which is frequently referred to as "a dry squash," contained less water and more reducing sugars than any of the other varieties. The Butternut was very rich in carotene, phosphorus, and potassium. Des Moines contained the smallest amount of carotene and ascorbic acid but the largest amount of calcium and magnesium of any of the varieties. Golden Cushaw was rich in carotene and contained the most protein, phosphorus, and potassium of any of the varieties included in this study. The results of the assays show considerable variation in the composition of the different varieties of winter squashes and of the different squashes within the varieties even though all were grown under uniform soil, fertilizer, and climatic conditions.

*Effect of Different Mulches upon the Nutritive Value of Tomatoes.* (Arthur D. Holmes, C. Tyson Smith, Charles Rogers and William H. Lachman.) An experiment of 6 years' duration was made to determine the possible effect of mulching upon the composition of tomatoes. A standardized Rutgers-Stokes strain of tomatoes was used. Plots with comparable soil were selected for three mulch treatments and a check, with two replicates of each. Four-inch layers of three types of mulch—horse manure with shavings, rye straw, and Servall (shredded sugar cane stalks)—were spread on the experimental plots as soon as the tomato plants were set out. During the past year, the sixth of the experiment, 12 samples

of 12 mature tomatoes each were assayed. The water, total solids, total sugars, and ascorbic acid contents of the tomatoes were similar for the check and the mulched plots. The tomatoes from the mulched plots contained more soluble solids and carotene than those from the check plots. Larger amounts of calcium, magnesium, phosphorus, and potassium were found in mulch-plot tomatoes than in the control-plot tomatoes. Judged by the results noted above, mulching tomatoes increases the mineral, especially phosphorus and potassium, content of the tomatoes.

**Studies on the Quantitative Estimation of Hemicelluloses.** (Emmett Bennett.) The data reported in the Annual Report for 1946-47 under this heading are published in the Journal of Analytical Chemistry.

Quantitative chemical procedures based on the removal of hemicellulose from holocellulose have received further consideration. Approaches have included (1) a study of the effects of acid hydrolysis, using different concentrations of acids, (2) alkaline extractions at different pH levels, and (3) means to determine when the holocellulose residue is substantially uniform, although possibly still retaining a quantity of furfural-yielding components. Results from the first and third approaches were of most promise. Limited data indicate that a slight increase in the concentration of the acid is more effective in bringing about hydrolysis than an increase in length of time. When plotted, these data also indicate that extraction is continuous. These observations would indicate that the whole cellulosic structure is attacked to some extent during the entire period of hydrolysis.

The alkali lability test, when applied to a holocellulose from which the hemicelluloses have been removed, yields an alkali number ranging from 0 to 3; before the hemicelluloses are removed by alkali, the number is of the order of 14. It would therefore seem possible to use the alkali number as a guide in determining approximately the time at which the incrusting hemicelluloses have been removed. The cellulosic residue is apparently not attacked appreciably by reagents used in this test.

**The Chemical Investigations of Hemicelluloses.** (Emmett Bennett.) Investigations dealing with the chemistry of hemicelluloses have been continued, with special attention to the hemicelluloses of corn stalks. Four different fractions when hydrolyzed yielded approximately 55, 68, 75, and 77 percent of reducing sugar as xylose. Specific rotations were all negative and had the values 40°, 46°, 34°, and 30°. Xylose appeared to be present in all fractions.

Quantitative estimations of xylose as the dibenzylidene dimethyl acetal did not prove successful and further work has been discontinued for the time. A good quantitative procedure for xylose would be very desirable. Because of certain disadvantages in the use of *o*-diphenylhydrazine for the determination of arabinose, attempts were made to utilize benzyl phenylhydrazine. The procedure, while fairly accurate for certain mixtures, was found to be unsuitable for general use.

Two of the fractions noted above yielded positive tests for starch, while two were negative. In each case the starch-like substance could be removed by treatment with a polidase-S enzyme preparation. Whether the presence of starch has a bearing on the origin of the pentoses is still an open question.

Results obtained thus far seem to indicate that fractions may differ qualitatively as well as quantitatively. In general, however, the fraction most resistant to extraction is likely to be the purest and the most homogeneous in character.

A report on the hemicelluloses of maize cobs and rye straw may be found in the Journal of Agricultural Research 75: 43-47 (1947).



**The Investigation of Agricultural Waste Products. I. The Chemical Investigation of Lignin.** (Emmett Bennett.) Attempts to increase the nitrogen content of lignin have been continued. Lignin was again oxidized by pure oxygen in a medium of concentrated ammonium hydroxide. It is known that organic compounds of phenolic nature absorb oxygen when dissolved in an alkaline solution. Ammonification appeared to take place simultaneously with oxidation. A maximum of over 8 percent of total nitrogen was obtained by oxidation for a period of 144 hours. The amounts of nitrogen combined, however, were not entirely proportional to the length of time of oxidation. The amount of ammoniacal nitrogen was approximately 34 percent of the total in all cases. This amount of nitrogen, which appears to be about the maximum attainable under the conditions, supports an hypothesis regarding the chemical structure of lignin.

In order to determine the extent to which changes were made during oxidation, the alkali lability test was used. Oxidations in this case were brought about in 0.2N sodium hydroxide. While it is doubtful whether a significant increase in the alkali number was obtained by oxidation for different intervals of time in sodium hydroxide, the number was significantly higher than that for samples oxidized in ammonium hydroxide.

That the size of the alkali number is, to a considerable extent, a function of the phenolic groups may be seen from the fact that when lignin is methylated, the alkali number becomes nearly zero. Furthermore the fixation of nitrogen seems to be dependent upon the hydroxyl groups, since nitrogen does not appear to be fixed to any extent in methylated lignin by oxidation with pure oxygen in concentrated ammonium hydroxide.

These data would tend to indicate that the formation of humus from lignin in the soil could be brought about by changes occurring in the hydroxyl groups.

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## THE CRANBERRY STATION East Wareham, Massachusetts

H. J. Franklin in Charge

**Administration.** As provided by the legislature, a cranberry extension specialist was added to the official staff at the Cranberry Station in October, 1947, Mr. J. Richard Beattie, County Agricultural Agent of the Plymouth County Extension Service, taking this position. He will have over-all charge of the cranberry extension work in all Massachusetts counties interested in the cultivation of this fruit.

**General.** Severe drouth with high temperatures and excessive sunshine in August did much to curtail the 1947 Massachusetts cranberry crop and depreciate its condition. This and record high temperatures in October were very harmful to a satisfactory marketing of the fresh fruit.

The general terminal fall and winter budding of cranberry vines in Massachusetts in preparation for the 1948 crop was conspicuously good, in very marked contrast to that of the previous year which was notably poor.

**Injurious and Beneficial Insects Affecting the Cranberry.** (H. J. Franklin.) The second part of the work on cranberry insects—that dealing with pests not worm-like and attacking mainly the cranberry foliage and fruit—was finished and presented for publication. The insect and disease control chart was revised and brought up to date.

*Chlorinated camphene*, used both as a dust and as a spray, proved to be a fairly effective control for gypsy moth caterpillars.

*Prevalence of Cranberry Insects in the Season of 1947:*

1. Black-headed fireworm clearly more troublesome than usual in both broods.

2. Gypsy moth caterpillars practically absent on the bogs in the eastern part of Barnstable County, as in 1945 and 1946. As this area was very heavily infested with this pest every year for a good many years before 1945, it is believed by some that the egg masses of the insect were killed by the penetrating salty spray driven by the 1944 hurricane.

The 1947 gypsy moth infestation in Plymouth County and the western part of Barnstable County considerable, probably about average.

3. False armyworm, spotted fireworm (*Cacoecia*), and firebeetle (*Cryptophalus*) infestations light or absent.

4. Cranberry sawfly caterpillars much more generally abundant than usual.

5. Fruitworm infestations spotty, but about normal on the average; much more troublesome than in 1945 and 1946.

6. Cranberry weevil and spittle insect much more abundant than usual on the Outer Cape, causing much concern there.

7. Red mites (*Paratetranychus*) more harmful on cranberry bogs than for many years.

8. Black cutworms on some bogs after removal of grub-control flood, but did less harm than usual.

9. Honeybees and especially bumblebees abundant on the bogs everywhere, though rather less so than in 1946.

**Weather Studies.** (H. J. Franklin and C. E. Cross.) Continuing interest in cranberry weather relations prompted further study, the results of which were prepared for publication as a supplement to Bulletin 433 of this Station. Important new information was obtained, that relating to the effects of the weather on the condition of the fruit having special value.

**Frost Forecasts.** (H. J. Franklin.) This special service was continued. Over 8000 acres of bog in the hands of 213 subscribers were covered by the telephone warnings, this being nearly four-fifths of the cranberry acreage with fair to full flowage protection. An accessory warning service by radio, in cooperation as heretofore with the United States Weather Bureau office at Logan Airport, was handled through Station WEEI at Boston.

**Bibliography of Cranberry Literature.** (H. J. Franklin.) From time to time, work has been done on a bibliography of cranberry literature. Cranberry literature has been carefully checked up to 1935, and about 1500 references have been made on 3 x 5 cards. The first reference found was in 1808. References were not numerous until about 1915, but since then there have been 25 or more a year. The literature from 1935 on is now being checked. When brought up to date, the bibliography will probably have over 2000 references, which it is planned to arrange by subjects. Any information on references to cranberries occurring in scientific journals where cranberry literature is not regularly published would be appreciated.

**Control of Cranberry Bog Weeds.** (C. E. Cross.) Since grasses, sedges, and rushes continue to be the chief weed problems of cranberry growers, efforts have been made to extend the season in which oils can be used selectively in the treatment of these weeds. The first two weeks of May continue to be the safest time for the treatment of weeds with both kerosene and Stoddard Solvent. Frost flooding of the bogs and rainy weather during these two weeks usually prevent the accomplishment of all the oil work projected on weedy bogs.

It is unsafe to spray Stoddard Solvent, even at the rate of 200 gallons per acre, after the terminal buds of cranberry vines have opened. Weather conditions at the time of spraying do not affect the results of spraying late in May—any new growth touched with this oil is seriously injured, though last year's leaves and stems may not be hurt. Any work in late May or early June with Stoddard Solvent must be done as an individual weed treatment, the oil being applied to the base of the weed only and kept from contact with any new growth on the cranberry vines.

Stoddard Solvent at 200 gallons per acre will kill asters, white violets, several species of *Panicum*, and numerous sedges and rushes. Experiments on a great variety of weeds are being continued.

Studies of the weather in relation to kerosene spraying have been made and lead to the following conclusions:

1. It is far more important that the bog be dry prior to oil treatment than that it remain dry afterward. Many grasses, sedges, and rushes die readily if dry when sprayed, even though rain falls immediately after treatment. The same types of weeds die after kerosene treatment even if the bog is flooded four hours afterward.

2. If cranberry vines have made some new growth, kerosene sprays can apparently still be used without vine injury if the shelter air temperature is 60°F. or lower. In some instances no injury occurred from kerosene spraying on vines with one inch of new growth when the temperature was 70°F. Too little is still known of the effect of humidity, sunshine, and wind velocity on the toxicity of oil sprays; but at present cool, cloudy, and windy days appear preferable to warm, bright, and calm days for late kerosene treatments.

Paradichlorobenzene was dissolved in kerosene and sprayed on cranberry vines and weeds. The addition of PDB does not add appreciably to the weed-killing properties of kerosene, the material dissolves only after excessive agitation, and the solution is very harmful to new growth on cranberry vines.

Further trials with paradichlorobenzene applied to cranberry bogs under one inch of sand indicate that the kill of small bramble (*Rubus*) and three-square grass (*Scirpus*) is inadequate to warrant the treatment. However, both spring and fall treatments using  $7\frac{1}{2}$  pounds of PDB per square rod under one inch of sand when wild bean is dormant appear to give nearly complete control of this weed.

When PDB is used under sand in new plantings, the cranberry vines develop so slowly that this treatment is not recommended.

Exhaustive tests of isopropyl phenyl carbamate failed to show any use for this material in cranberry weed control.

**Winterkilling Studies.** (C. E. Cross.) Experiments during the last two winters have shown that a single layer of 8-ounce burlap is sufficient to prevent the winter-killing of cranberry vines. The same is true of rough cotton cloth such as is used in the making of 100-pound sacks. Two thicknesses of tobacco netting did not give adequate protection to the cranberry vines. Substantially more cranberries were harvested from areas covered with cotton and burlap than from unprotected areas.



**Frost Experiments.** (C. E. Cross.) Burlap and cotton cloth were used on bogs to determine what degree of frost protection they would afford as covers over cranberry vines. Temperatures on frosty nights ranged from 4 to 8 degrees F. warmer under the coverings—the more severe the frost, the greater the protection. Paper was tried as a cheaper material. Though it apparently afforded good protection from low temperatures, it could not be anchored even in light winds, and is therefore considered impractical.

**Soil Water Studies.** (F. B. Chandler.) Studies of soil water made with wells and with tensiometers (instruments to measure the tension required to move water in the soil) show that one section of a bog is not uniform in water movement for drainage or irrigation. Some bog sections or parts of sections may be poorly irrigated although the ditches are filled with water. During the coming year, several growers are cooperating and more data will be available later.

**Fertilizer Requirements of Cranberry Plants.** (F. B. Chandler and William G. Colby.) The plots previously started have been continued and about 100 new plots added, for the purpose of studying the different sources of nitrogen (nitrate of soda, sulfate of ammonia, cyanamid, Urea-form and tankage), sources of phosphorus (rock phosphate, normal superphosphate, and triple superphosphate), amounts of nitrogen per acre (10, 20, 40, and 80 pounds of nitrogen per acre), and ratio of nitrogen to phosphorus (1-1 and 1-2.) Time of application and minor elements are also being studied. The results so far do not justify any recommendations.

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## DEPARTMENT OF DAIRY INDUSTRY

D. J. Hankinson in Charge

**Sanitizing Agents for Dairy Use.** (W. S. Mueller.) The newer sanitizing agents for dairy use have in common a quaternary ammonium salt of one form or another which is the active bactericidal material. A new development is a cleaner-sanitizer combination. These new products are now available in both liquid and powder form.

Some of the results of this study, "Testing Quaternary Ammonium Sanitizers and Their Use in the Dairy Industry" were published in *Soap and Sanitary Chemicals*, September, 1947 issue.

The following progress has been made:

1. *A Method for Evaluating the Sanitizing Efficiency of Quaternary Ammonium Compounds and Other Germicides Proposed for Sanitizing Food Utensils.* (W. S. Mueller and E. P. Larkin.) The method is described in the last annual report. During the past year more data have been obtained on several technical steps, for the purpose of improving the standardization of the suspension of test organisms as used in the test. A hand homogenizer was used for breaking up clumps of bacteria in suspension. A spectrophotometer was used for measuring the turbidity of the bacterial suspension and this value was correlated with the number of bacteria present as determined by the plate count. Three distinct types of bacteria were used in the study: a gram-negative organism, *E. coli*; a gram-positive organism, *S. aureus*; and a sporeformer, *B. cereus*. The different organisms were variously affected by homogenization. The plate count of *S. aureus* was increased 70 percent; that of *B. cereus* was slightly decreased. No significant effect was noted on *E. coli*.

Curves plotted for each of the three organisms show the relationship between the plate count and turbidity value as measured by the spectrophotometer. Results indicate that suspensions of non-sporeforming organisms can be standardized to a reasonably accurate number by the use of transmission curves. Results with *B. cereus* were doubtful; therefore standardization of spore suspensions by the use of the homogenizer and spectrophotometer cannot be recommended at the present time.

2. *New Developments in Sanitizing Teat Cups Between Cows Milked.* (W. S. Mueller and D. B. Seeley.) The method commonly used today for sanitizing teat cups between cows milked is ineffective because contact with the germicide is too short. This is a major cause for the spread of mastitis from an infected to a non-infected udder.

As a result of this study, a new method for sanitizing teat cups has been developed, in which the basic idea is the use of an extra milking-head assembly, thus making it possible to keep the teat cups in the germicidal solution for two minutes or more without increasing the milking time for the herd. This markedly reduced the total bacterial counts of the teat cup and under laboratory conditions killed almost all of the *S. agalactiae* organisms, which are chiefly responsible for mastitis due to infection.

From this study it is concluded that the new method of sanitizing teat cups between cows milked greatly reduces the chance of spreading mastitis through the herd, without increasing milking time or interfering with barn routine.

3. *Effect of Some Water Constituents on Quaternaries.* (W. S. Mueller and D. B. Seeley.) While "hard waters" have been reported to be incompatible with quaternaries, it seemed desirable to have more information on the effect of each of the many constituents normally found in potable waters. The germicidal potency of an alkyl-dimethyl-benzyl-ammonium chloride was tested against *E. coli*, and the tentative conclusions are as follows:

a. There was no direct correlation between water hardness as measured by the soap method and the germicidal potency of the quaternary solution.

b. The following ions had no adverse effect on the germicidal potency of the quaternary: cations—potassium, sodium, and lithium; anions—chloride, sulfates, and nitrates.

c. The following cations when present in sufficient quantities reduced the effectiveness of the quaternary: calcium, magnesium, and bivalent and trivalent ionized iron. Calcium and magnesium acted alike; trivalent ionized iron was far more detrimental than bivalent ionized iron.

d. A 200 p.p.m. solution of the quaternary studied had sufficient germicidal potency to do most sanitizing jobs even when the concentration of calcium plus magnesium was as much as 600 p.p.m.

e. A 200 p.p.m. solution of the quaternary was completely inactivated by 10 p.p.m. of trivalent ionized iron.

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## DEPARTMENT OF ECONOMICS

Philip L. Gamble in Charge

**Transfer of Ownership and Its Effect on Agricultural Land Utilization.** (David Rozman.) Work on this project has proceeded with the examination of records obtained in agricultural communities in several parts of the State. The Registry of Deeds and assessors' records have provided the basis for a complete list of land transfers in the selected areas, from the beginning of 1940. The towns

studied during the past year were New Braintree in Worcester County, Amherst in Hampshire County, and West Newbury in Essex County. The study involves ascertaining present as well as former uses of each individual property. Further information is obtained from the records of the Agricultural Conservation Service so far as they are available. For the years already examined and analyzed, the following preliminary data indicate the changes occurring in agricultural land use and ownership.

There has been a continuous increase in the number of transactions affecting agricultural land throughout the period, reaching greatest intensity in the immediate postwar year. The number of transactions in the three towns under consideration increased from 32 in 1940 to 69 in 1946; and the number of acres involved, from 858 to 2700. In most cases the type of land use has shown a change under new ownership in both the prewar and the postwar periods. In 1940, out of a total of 32 transfers, only 13 farm units retained their former use; and in 1946, only 19 out of 69. Some of the farming units lost their identity after transfer and became part of a larger farming unit.

Changes from part-time farming into full-time farming or the reverse occurred in about equal numbers, both in the prewar period and in 1946. On the basis of incomplete preliminary figures, it appears that the movement of farm land into non-farming use is somewhat greater than the reverse movement of non-farm land into farms.

As a part of the study of the general trend in Massachusetts agriculture, an agricultural production program for 1948 was worked out and published in mimeographed form.

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## DEPARTMENT OF ENTOMOLOGY

Charles P. Alexander in Charge

**Investigation of Materials Which Promise Value in Insect Control.** (A. I. Bourne, W. D. Whitcomb, W. J. Garland, and C. S. Hood.) In the cooperative experiment with the Dow Chemical Company, dormant application of experimental materials D-289 and D-542 on apple killed overwintered eggs of apple aphids. Unsprayed trees in the test block showed 2050 aphids per 50 buds, with some buds showing as many as 105 plant lice; while on sprayed trees only an occasional bud showed a single aphid. No retardation in seasonal development resulted from either material.

Dormant application of D-289 and D-542 on sweet cherries practically eliminated black cherry aphid for the season. For the first time since this block had been set out, the trees were practically free from the evidence of this pest. No further steps were taken to control aphids in this block during the entire season, in contrast to previous years when several sprays of nicotine sulfate had been applied each year in an unsuccessful effort to check this pest.

Dormant application of D-289 and D-542 in the variety pear block gave very good control of pear psylla, although protracted cold windy weather so prolonged the appearance of adult psyllas that the dormant application was not quite so effective as in 1946 when more normal weather prevailed.

Laboratory tests of D-289 on egg masses of eastern tent caterpillar showed promising reduction in numbers of emerging larvae. The light infestation in this area made it impossible to operate on any large scale. Results were sufficiently good to warrant further study in a season of greater attack.



B-542 in dormant application on cultivated blueberries gave striking control of a very troublesome species of *Lecanium* (*L. quercifex*). Results with this material were so nearly perfect that we hope to spray the entire blueberry plantings in college plots and eradicate this potentially serious pest. This is one of the first successful attempts to control this pest on blueberries.

At Waltham, experimental applications of new materials for the control of summer infestations of the European red mite were made on August 13 and 18, 1947, where the average infestation was 4 to 6 mites per leaf. Counts of 60 leaves per treatment 10 to 14 days later showed excellent control from all materials, as follows:

Code Number	Formula	Dosage (per 100 gallons)	Reduction of Mites per Leaf (percent)
C-740	Chlorophenyl ethane and DDT	2 quarts.....	98.8
C-714	Chlorophenyl ethane	1 pint	} 97.7
+C-726	Chlorophenyl methane	20 ounces.....	
D-111	Dinitro ortho cresol	16 ounces.....	96.8
Check	None		5.2

Abnormally high temperatures and prolonged drouth occurred in the period covered by this experiment, and C-740 caused moderate foliage injury under these conditions.

**Insecticides for the Control of the European Corn Borer.** (A. I. Bourne.) The first brood infestation in general was comparatively light, although some fields in well-protected areas in the lower Connecticut Valley showed considerable damage. The second brood was more serious, and many late plantings which were untreated suffered severe damage. Cold wet weather in May retarded pupation, which, for the most part, took place at irregular intervals following an occasional warm day. Moth emergence was correspondingly delayed and the first eggs were observed about June 10. First hatching was noted about mid-June.

Growth of corn was somewhat retarded by the same weather conditions. In some fields planted April 29, the plants were just breaking ground by mid-May and only reached a height of 3-4 inches during the warm period in the closing days of the month. Cool weather during most of June did not improve conditions greatly. Very hot weather in the last days of June and through July, however, stimulated rapid growth and the earliest planted fields were ready for harvest by about July 25.

Corn borer damage in the experimental plots was not severe even in untreated plots, where the average from all pickings was 85 percent clean corn compared with an average of 98 percent clean corn in treated plots. However, in the check plots only 75 percent of the yield was of marketable grade, and the total yield averaged 35 percent more marketable ears in the sprayed plots than in the check plots. The heaviest yield was on the Derris and Ryanex plots, which averaged 42.4 percent more ears of marketable grade than the unsprayed check plots, indicating that, even with a moderate infestation, feeding of the larvae lowered the vitality of the plants enough to cause not only a reduction in total yield but an even more serious reduction in ears of marketable quality.

**Potato Spraying Experiments.** (A. I. Bourne.) Potatoes were planted on May 12. May was slightly cooler than normal, with slightly more precipitation than usual, well distributed over the month as light rains except for two storms on the

3d and 25th. Cold weather somewhat retarded the first appearance of the plants, but once they broke ground they made steady and satisfactory growth. June also was slightly cooler and rainfall slightly less than usual. Growth was somewhat slow but was not seriously interrupted. The balance of the growing season was warm and very dry. The location of the experimental plots in rather a low area and on heavy soil prevented serious retardation, and the plants progressed very well and matured a good crop.

No spray injury was noted at any time during the season except a possible trace following calcium arsenate. The plants showed a tendency to ripen slightly earlier than usual but many were alive until the heavy killing frost in late September. This was very noticeable on the DDT plots, which remained green right up to frost.

Early flea beetle attack was comparatively negligible, but by late July the second brood appeared in some size and continued to mid-August. A moderate infestation of plant lice appeared in early August. Aphids were in moderate abundance through all plots except those given DDT emulsion, where only a few appeared.

Fifteen applications were made at weekly intervals from June 12 to September 17 to protect all new growth from attack. At least three extra applications were made to furnish protection in case of the recurrence of blight, which caused such havoc to tomatoes and potatoes in 1946. By mid-August the plants in the Bordeaux-sprayed plots began to show less vigor and considerable scarring from flea beetle attack. Where calcium arsenate was added, somewhat less flea beetle damage was noted, but there was a light amount of spray injury. The plots receiving DDT were of superior appearance, upright, vigorous, and remarkably free from any trace of insects.

The contrast between the DDT plots and the other plots grew more noticeable as the season advanced. Examination of growing tips from the different plots indicated the protection furnished by DDT. Samples from the Bordeaux plots showed 4560 perforations per 10 tips, while similar samples from the DDT (wetttable powder) plot showed only 264 feeding punctures and from the DDT (emulsion) plot, 220; and superficial examination of the plants in the latter plots failed to indicate any damage.

Yields were high in both plots sprayed with DDT. The highest yield was slightly over 466 bushels per acre in the plot where the DDT emulsion was applied. The yield in the DDT (wetttable powder) plot was 96 bushels per acre (or 30 percent) greater than in the adjoining Bordeaux plot; and where the DDT emulsion was applied, the increase in yield was 148 bushels per acre or 46.5 percent greater than where Bordeaux alone was used.

**Control of Onion Thrips.** (A. I. Bourne.) Onion sets were preferred to seed onions because the cold, wet spring season prevented early preparation of the plot and sets would furnish material for tests much earlier than would seed onions.

Thrips infestation developed slowly after a somewhat late appearance. A very few were found by the third week of June, and hot dry weather in July promoted rapid increase. Throughout the Valley, the prevailing weather conditions delayed thrips development so that many of the fields of set onions were pulled before thrips had reached very great numbers. Some of the plantings of seed onions, maturing later in the summer following the hot dry weather of July and August, showed moderately heavy attack.

The first application of insecticides was on July 15 when the plants averaged 15 to 16 inches in height and had an average of about 30 thrips per plant, a comparatively light infestation.

Following very thorough application to relatively small plants, all the sprays gave excellent initial kill: Black Leaf 40, Ryanex, and DDT, 99 percent control; Derris and DDD, 95 percent or over. After 7 days, the Derris, DDT, and DDD plots showed no increase in thrips population; Black Leaf 40 and Ryanex, however, did not give prolonged protection.

Of the dusts, DDT and BHC (benzene hexachloride) gave practically complete control following heavy application, and only slight increase in thrips population after a 7-day interval. Plants dusted with BHC retained a pronounced odor for weeks, but the onions when harvested did not have their flavor impaired. Ryanex dust gave approximately 94 percent control.

**Control of Cabbage Maggot.** (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) The natural infestation of the cabbage maggot in the experimental planting at Waltham caused 79 percent commercial injury in 1947. In the same planting, one and two applications at 10-day intervals of benzene hexachloride-talc dust at the rate of 25-30 pounds per acre gave perfect control. The most effective dusts contained 5 and 3 percent benzene hexachloride, but dust containing 1 percent benzene hexachloride was commercially satisfactory.

Benzene hexachloride harrowed into the soil at the rate of 2 pounds per acre before transplanting failed to give satisfactory protection.,

The treatments which gave excellent control produced 85 to 95 percent marketable heads, and there was no taste or odor contamination at harvest. Although no records were obtained, observations indicated that the cutworm injury was completely eliminated by these treatments.

**Studies of Odor and Taste Contamination from Soil Treatment with Benzene Hexachloride.** (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.)

Benzene hexachloride is an effective insecticide for the control of wireworms and cabbage maggot. However, it has a strong, persistent musty odor and taste which may be imparted to vegetables grown in treated soil.

In the experimental garden where areas were treated with benzene hexachloride at the rate of 2, 3, and 5 pounds per acre, carrots, onions, parsnips, and radishes were judged free from odor or taste contamination at the harvest by fifteen disinterested testers. Potatoes were contaminated at all dosages, and beets at the higher rates of application.

In general, the odor and taste of BHC were accentuated by boiling and baking. Potatoes still retained the odor to an undesirable degree seven months after harvest. Radishes and turnips were contaminated when the benzene hexachloride was applied as a dust to the plants after the shoulder was developed above ground.

**Control of Squash Vine Borer.** (W. D. Whitcomb, W. J. Garland, Waltham.) The natural infestation by the squash vine borer in the experimental plantings at Waltham in 1947 was 49.5 borers per vine. Applications of dust gave appreciable protection when applied at weekly intervals during July.

The most effective treatment was dusting with 3 percent DDD (Rhothane) which gave 81.6 percent protection. Other dusts which gave satisfactory protection were effective in the following order: 5 percent methoxy DDT; 0.5 percent DDT plus 0.06 percent pyrethrins; and 40 percent ryania powder.

The infestation in both the untreated and the dusted plants was about 30 percent greater in *Cucurbita maxima* plants than in *C. pepo*.

**Biology and Control of Common Red Spider on Greenhouse Plants.** (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) Parathion, a new organic phosphate insecticide, was found to be very effective for control of the



greenhouse red spider on greenhouse roses when used as a 25 percent wettable powder. Infestation before spraying averaged 35.6 spiders per leaf on Better Times variety, and 14.8 spiders per leaf on Briardcliff. When Parathion was applied as a spray at the rate of  $\frac{1}{4}$ ,  $\frac{1}{2}$ , and 1 pound (equivalent to 1, 2, and 4 ounces of toxicant) per 100 gallons of water, all spiders were killed at each dilution. Furthermore, all spiders were killed on specimen plants protected by a hood of sheeting cloth, indicating very effective toxic action from the fumes. Mask and gloves were used during application.

No spiders have been found on these plants for three months after spraying, and no significant injury to the rose plants occurred.

**Apple Maggot Emergence.** (W. D. Whitcomb, Waltham.) Emergence of apple maggot flies at Waltham was the latest for any season since the cages have been operated, and applications of spray and dust for control of this pest, consequently, were delayed. The first fly was not found until July 6 which is 10 days after the average (8-year) date. Fifty percent emergence was reached on July 20, and flies continued to appear until August 18, which is about two weeks later than usual.

**Control of Plum Curculio in Apples.** (W. D. Whitcomb, Waltham.) In the vicinity of Waltham, the plum curculio continued to be the most destructive insect pest of apples. On four unsprayed trees, 594 curculio beetles were collected by jarring between May 28 and June 18, 1947. Peak collections on June 2 and 16 indicated the periods of maximum activity when spraying was necessary for effective control.

In laboratory examinations the number of eggs in gravid female beetles was found to average 29.6, with a maximum of 43.

Insectary experiments using five pairs of beetles per cage, with apples as food, showed 41 punctures per beetle on the unsprayed apples in the 30 days of the experiment. DDT-lead arsenate killed all of the beetles in 6 days, with 2 punctures per beetle. BHC (benzene hexachloride), 3 pounds of 6 percent gamma isomer in 100 gallons of water, was about half as effective, and at 2 pounds per 100 gallons was unsatisfactory. The addition of HETP (hexaethyl tetraphosphate) 1-1600 prevented oviposition completely and gave excellent protection for about 7 days.

In orchard experiments involving the examination of about 18,000 apples, the combination of lead arsenate 2 pounds and 50 percent DDT wettable powder 2 pounds in 100 gallons gave the best control and was more effective by about 8 percent than lead arsenate alone at either 4 or 6 pounds in 100 gallons. BHC, 6 percent gamma isomer, at the rate of 3 pounds in 100 gallons permitted 42 percent of the fruit to be stung and was unsatisfactory. The addition of HETP 1-1600 to lead arsenate was less effective in the orchard than in the laboratory because its rapid breakdown failed to maintain protection between applications.

**Study of Naphthalene and Similar Compounds as Greenhouse Fumigants.** (W. D. Whitcomb and W. J. Garland, Waltham.) Experimental fumigations with aerosols containing a naphthalene base fumigant (Fulex) failed to satisfactorily control the common red spider on carnations in one 4 or 6 hour exposure (47-58 percent dead), but were effective in two successive exposures at 7-10 day intervals (86-100 percent dead). The aerosol was effective when discharged into the upper part of the room, but not from the floor.

Effective formulae were 25 percent Fulex concentrate with Freon and 20 percent Fulex-azobenzene with Freon. Addition of approximately 5 percent gamma isomer of benzene hexachloride to both Fulex concentrate and Fulex

azobenzene aerosols gave 100 percent control of aphid on carnations and maintained the same effectiveness against the red spider mite.

Experimental fumigations in a commercial greenhouse with four applications of 17.5 percent azobenzene powder in a pressure fumigating can failed to give satisfactory control of the citrus mealybug on gardenia, although aphid and red spider mite were completely killed. The standard dosage of 2 pounds per 20,000 cubic feet was increased to  $7\frac{1}{2}$  pounds without controlling the mealybug. No injury to gardenia plants occurred, but the blooms and the paint on the greenhouse were noticeably stained.

**Biology and Control of the Celery Plant Bug.** (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) Although the first generation of the celery plant bug (*Lygus campestris* L.) in July, 1947, was very small, the second generation in August and September was moderately abundant and control measures were necessary on many celery plantings in eastern Massachusetts.

Life history studies showed the time for development from egg to adult was 18.3 days in August, and 32 days in September, the difference being due almost entirely to the slow growth of the fourth nymphal instar during the cool weather in late September.

Sprays and dusts to control injury by bugs of the second generation were applied August 15 and September 3. DDT wettable powder in sprays containing 0.12, 0.06, and 0.03 percent DDT gave excellent control with no significant differences between the dosages, although reinfestation was prevented in direct proportion to the dosage. A dust containing 0.5 percent DDT and 0.06 percent pyrethrum was as effective as the sprays containing DDT. Dusts containing 40 percent ryania and 5 percent methoxy analog of DDT were unsatisfactory.

The size and weight of the average celery plant were significantly correlated with the injury by the celery plant bug in most control treatments, as shown in the tabulation.

Treatment	Injured Stalks at Harvest	Average Weight of Stalks
<b>Spray</b>	(percent)	(ounces)
DDT 50, 2 pounds per 100 gallons	None	46.4
DDT 50, 1 pound per 100 gallons	2.63	47.0
DDT 50, $\frac{1}{2}$ pound per 100 gallons	3.50	50.2
<b>Dust</b>		
DDT 0.5 percent-pyrethrins 0.06 percent	5.26	50.6
DDT 3 percent	8.77	45.2
Ryania 40 percent	45.61	42.8
Methoxy 5 percent	64.91	47.0
Check	74.34	38.2

Preliminary analyses by A. F. Spelman of the Control Service showed DDT residue well within the tolerance of 7 p.p.m. three weeks after treatment in July. In August the residue on the stalks was satisfactory, although with the stronger sprays the residue was excessive on the leaves but not on the stalks. Further analyses are needed and are planned.

**Biology and Control of the Grape Cane Girdler.** (W. D. Whitcomb, Waltham.) Grape cane girdler beetles lived an average of 61 days when confined in cages with a supply of fresh grape canes daily, and made an average of 234 feeding

scars per beetle. The greatest activity occurred between June 20 and July 15, but feeding was continued to September 19, which was 99 days after the observations were started.

DDT 50 percent wettable powder sprayed on canes in the insectary cages killed 4 pairs of beetles in 3.12 days and permitted 0.87 feeding scars per beetle during their life. Of ten different combinations and dosages of DDT, lead arsenate, and benzene hexachloride, five killed the beetles more quickly and seven prevented as many feeding scars. Benzene hexachloride reduced feeding scars by 57 to 86 percent and was significantly more effective in this respect than DDT or lead arsenate.

**Study of Euonymus Scale and Its Control.** (W. D. Whitcomb and C. N. Warner, Waltham, in cooperation with the Bartlett Tree Expert Company.) Studies on the Euonymus scale were started early in 1948 with dormant spraying treatments. When an 83 percent white oil emulsion was used in sprays containing 2, 3, and 4 percent actual oil, only the 4 percent dilution was satisfactory.

Reinfestation by crawlers following dormant sprays was reduced 100 percent by Elgetol 1½ percent; 98.7 percent by Elgetol 1 percent; and 86.9 percent by 4 percent oil emulsion.

In 1948 the first crawlers hatched June 14 and maximum activity was reached June 28-July 2 which is considerably later than has been estimated previously. Microscopic examination of female scales showed a maximum of 81 and an average of 61.5 eggs per scale.

An examination of 35 species and varieties of Euonymus growing at the Arnold Arboretum showed 8 species and 8 varieties heavily infested and 5 species and 4 varieties uninfested. No infestation was found on *E. alata* and its varieties, while *E. europea* and its varieties were all heavily infested.

**Sprays to Prevent Scolytid Infestation of Elm Logs.** (W. B. Becker.) At Springfield a number of sprays were applied once in the early spring when the weather was still cool (March 13, 1947) to the entire bark surface of winter-cut logs of American elm before Scolytids could attack them. Each test involved 20 to 22 square feet of bark with a maximum thickness between 3/8 and 3/4 of an inch and the quantity of spray applied was what the operator estimated to be necessary to thoroughly wet the surface of the bark (66 to 155 ml. per square foot). *Scolytus multistriatus* Marsham is abundant in the vicinity, but only *Hylurgopinus rufipes* (Eich.) infested the unsprayed control logs exposed at this season.

One percent DDT sprays (a wettable powder, an emulsion, and solution in No. 2 fuel oil), orthodichlorobenzene in No. 2 fuel oil (1 to 8 by volume), pentachlorophenol in No. 2 fuel oil (1 to 10 by volume), and monochloronaphthalene in No. 2 fuel oil (1 to 12 by volume) all gave 100 percent prevention, based on the number of exit holes found per square foot of bark in the late fall, as compared with the number in unsprayed check logs. The spraying of frozen or ice-coated logs, of course, may not result in such good control.

Other logs cut at the same time were sprayed as above but during warm weather (June 13, 1947). Each test involved 20 to 24 square feet of bark with a maximum thickness of 3/8 to 3/4 of an inch. Between 104 and 133 ml. of spray were applied per square foot of bark. Apparently the logs had only recently been attacked when the spray was applied, because boring dust was on the logs then; but examination in the fall revealed that eggs had hatched in few to none of the egg galleries in the sprayed logs. While no *S. multistriatus* were found in any of the sprayed logs, the ratio of *S. multistriatus* to *H. rufipes* brood galleries in the unsprayed control logs was 1 to 8.



In comparison with the control logs, 100 percent prevention or control was obtained with No. 2 fuel oil alone, pentachlorophenol in No. 2 fuel oil (1-10 by volume), and monochloronaphthalene in No. 2 fuel oil (1-12 by volume). The one percent DDT wettable powder spray and the orthodichlorobenzene in No. 2 fuel oil (1-8 by volume) gave 91.6 and 84.2 percent prevention, respectively, based on the number of exit holes per square foot of bark; but on the basis of the number of exit holes per egg gallery (with and without hatched eggs) 76.6 and 79.9 percent control, respectively, was obtained.

**Spraying to Prevent Twig Feeding by the Smaller European Elm Bark Beetle.** (W. B. Becker.) Several new insecticides were tried in four types of spraying applications to prevent twig feeding on American elms by the smaller European elm bark beetle, *Scolytus multistriatus* Marsham, using the method described on pages 41-42 of last year's annual report (Bulletin 441).

1. *With Small Compressed-air Garden Sprayers.* The sprays were applied thoroughly at close range to low-growing branches of elms. Dormant and foliage applications of commercial DDT emulsion and wettable powder sprays at the low strengths found successful against many defoliating insects did not give good protection against *S. multistriatus* twig feeding after many days of weathering. No spray injury resulted to the elms at these low concentrations.

*Dormant applications:* Higher concentrations of several commercial DDT emulsions gave increasingly longer protection on the sprayed portions of twigs. Good protection for 100 days was sometimes obtained with 1 percent DDT emulsions, but much less often with 0.5 percent; while 2 percent DDT emulsions were effective for 200 days. The addition of lead arsenate to DDT emulsions (38 grams per gallon of 0.5 percent DDT spray) made no great difference in the results obtained at that strength. A 4 percent chlordane emulsion did not remain effective so long as a 1 percent DDT emulsion. No spray injury to the elms resulted from any of these dormant applications.

*Foliage applications:* In mid-August, 2, 1, and sometimes 0.5 percent commercial DDT emulsion and wettable powder sprays applied to previously unsprayed elms gave complete protection on sprayed parts of twigs for 109 to 113 days, after which these tests were suspended. No spray injury to the elms resulted from the wettable powder sprays, but slight foliage injury resulted from some 1 percent commercial DDT emulsions and moderately severe injury from some 2 percent DDT emulsions. Sugar maples and some other plants growing next to sprayed elms were injured more than the elms by these sprays. Spider mite damage sometimes followed DDT applications to elm foliage. A 2 percent chlordane emulsion gave much shorter protection and caused no injury. Wettable powder sprays of benzene hexachloride (151.4 grams of a 50 percent wettable powder per gallon), Ryania SC50 (76 grams per gallon), and Ryanex (151.4 grams per gallon) gave still less protection but caused no injury.

2. *With High-powered Hydraulic Sprayers* (35 gallons a minute capacity): Only DDT emulsions, commercial and laboratory-prepared, were used in this equipment. On low branches protection was somewhat comparable to that reported for DDT emulsions in the previous section. The principal difficulty lay in obtaining equally long-lasting protection in the upper parts of the elms, even though the spray always reached over the tops of the trees, which were up to approximately 60 feet high. As much as 25 gallons of spray was used on individual elms of medium size for thorough coverage.

*Dormant applications:* DDT emulsions, 1 and 2 percent, gave good, sometimes complete, protection at the top of an elm 41 days later. After 64 days, protection at the top was poor to fair from the 1 percent emulsion and poor to good from the 2 percent emulsion. After 112 days, protection was practically all poor at the top. No spray injury to the elms resulted.

*Foliage applications:* In mid-August these same elms were sprayed again and others sprayed for the first time. Special attention was given to spraying the tops. With 1 percent DDT emulsions, protection at the tops was poor to good 67-70 days later, but mostly poor after 117 days. With 2 percent DDT emulsions, protection at the tops was good after 67-69 days and fair to good after 117 days. Little to no injury to the elms resulted from these applications.

3. *With Mist Blowers:* The mist blower described in last year's annual report (Bulletin 441, p. 42) was used again. When the low dosages reported as successful against gypsy moths and other defoliating insects on shade trees (up to 1 quart of a 12 percent DDT solution or emulsion per medium to large elm) were applied in these experiments or with a similar mist blower on a regular municipal tree spraying operation, good protection against twig feeding by *S. multistriatus* was not obtained at any height, even after only a few days of weathering.

*Dormant applications:* When one gallon of a 12 percent DDT solution (diluted with kerosene) was sprayed at a medium to large elm, protection at the top was poor 43 days later. Two gallons gave somewhat better results then, but very poor results after 73 days. Three gallons gave good results at the top after 71 days but poor results after 148 days. None of these applications caused noticeable injury to dormant elms, but a sugar maple growing close to the elm which received three gallons was severely injured by the spray.

*Foliage applications:* One gallon of a 12 percent DDT emulsion, applied per tree in mid-August, gave poor results 43 days later at the top of a tree which had not been previously sprayed. Protection at the tops was fairly good from two and three gallons per tree after 44 days, but was poor after 77 days from two gallons and only slightly better from three gallons. Better protection was always obtained in the lower parts of the trees and was in proportion to the amount sprayed at the tree. These mid-August foliage applications caused little noticeable injury to the elms, except on the lower branches of the tree which received three gallons of the emulsion and where the blower passed too close to the other trees.

4. *With an Airplane.* Through the courtesy of the Field Headquarters, Gypsy and Browntail Moth Control, of the U. S. Bureau of Entomology and Plant Quarantine, and the Entomology Department of the Connecticut Agricultural Experiment Station, the effectiveness of airplane applications of DDT against twig feeding of *S. multistriatus* was studied. Deciduous forest areas in Connecticut were sprayed by airplane early in the spring with DDT at dosages used experimentally to combat gypsy moth caterpillars. Flying and spraying conditions were reported excellent, no foliage was yet present, and all glass plates at the site of these experiments, both on the ground and on branches, were well covered with the spray. Prevention of *S. multistriatus* feeding was unsatisfactory throughout the tests, which lasted 48 days. Even after only three days of weathering on a plot sprayed with as much as 2 pounds of DDT (technical grade) dissolved in 2 gallons of liquid (xylene and kerosene) per acre, only 45.4 percent prevention was obtained. All elm twigs used in this test were from branches 20 to 30 feet high in the tree.

**DDT Residues on Grass Beneath Elms Sprayed for Elm Bark Beetles.** (W. B. Becker and A. F. Spelman.\*) The Feed and Fertilizer Regulatory Service cooperated by making DDT analyses of grass collected from pasture areas on which the spray dripped and drifted from elms sprayed with DDT emulsion from high-powered hydraulic sprayers. DDT (technical grade) was used at the rates of 16 and 8 pounds per 100 gallons, and as much as 25 gallons of spray was applied per tree. The residue was determined by the total chlorine method and *based on the oven-dry weight of the grass.*

August 15 application (soon after removal of cut hay); After 4 days with 0.52 inches of rainfall, the residue from the 16-pound application was 6,885 p.p.m. DDT; from the 8-pound application, 4,035 p.p.m. After 68 days with 4.55 inches rainfall, the corresponding residues were 1,658 and 851 p.p.m.

April 25 application: After 96 days with 11.63 inches rainfall, the residue from the 16-pound application was 43 p.p.m. DDT; from the 8-pound application, 45 to 50 p.p.m.

Such high DDT residues would seem to be undesirable and possibly hazardous where food for man or animals is involved. More detailed studies are in progress.

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## FEED AND FERTILIZER CONTROL SERVICES

John W. Kuzmeski in Charge

The feed, fertilizer and milk testing laws are administered as one service and the operation of each, with the exception of the milk testing law, is reported in annual bulletins.

Under the milk testing law 4,915 pieces of Babcock glassware were calibrated and 177 certificates of proficiency in testing were issued. All milk depots and milk inspection laboratories in the Commonwealth were visited at least once to check apparatus and general conduct of the work.

In addition to the regulatory work the Feed and Fertilizer Control laboratories have examined feeds, fertilizers, and other agricultural materials for citizens of the Commonwealth without charge whenever the results were considered of interest to the general public or to the Control Services.

Considerable work has been done on research projects in cooperation with other departments of the University and Experiment Station. The results of such work are reported by the departments originating the projects.

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## DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

**Breeding Snapdragons for Variety Improvement and Disease Resistance.** (Harold E. White, Waltham.) A dark pink flowered strain of Helen Tobin has been developed into a pure inbred line and seed has been distributed to local growers. The original Helen Tobin, which is a light pink variety, has been reported by several florists to be a good spring blooming variety to follow chrysanthemums. This variety, since its first introduction, has been used very successfully for an outdoor crop by a florist near Tampa, Florida; this year the firm plans to grow a crop of 8,000 to 10,000 plants. George J. Ball, Inc., West Chicago, Illinois, and other commercial growers are using Helen Tobin as breeding stock because it is an excellent seed producer and has other desirable characters.

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\* Senior chemist, Feed and Fertilizer Regulatory Service.



Excellent hybrids of the Tobin variety have been produced by inter-crossing with other commercial varieties. Local florists have been using these hybrids for two years with fine results. A sufficient quantity of stock seed of Tobin hybrids is being produced at Waltham to supply these growers.

The Waltham Field Station rust-resistant, pink-flowered strain of snapdragon for garden culture is being tested by approximately fifty home gardeners in the State. These tests are being conducted in cooperation with the Garden Club Federation of Massachusetts. The variety will be named and provisions made for introduction through local seedsmen if performance in these tests is satisfactory.

**Sodium Selenate as a Red Spider Control.** (Harold E. White, Waltham.) Carnation plants growing in benches were treated with selenium-bearing phosphate known in the trade as P-40. Applications were at the rate of 3, 4½, and 6 pounds per 100 square feet of bench area. Two applications of this material were made during the growing season, one in August and a second in November.

All the treatments at the higher dosages, 4½ and 6 pounds per 100 square feet, gave effective control of red spider from November through June, a period of 8 months. Red spider became abundant in May and June on untreated carnation plants and on those receiving the dosage of 3 pounds of P-40 per 100 square feet.

Ageratum, Lantana, Coleus, and Stevia were grown in 5-inch pots and treated with P-40 at the rate of ¼, ½, and 1 teaspoonful per pot. The ¼ teaspoonful dosage did not give effective control over a period of 6 to 8 weeks and the ½ teaspoonful treatment gave only partial control. The dosage of 1 teaspoonful P-40 per pot gave complete control.

Neither carnation plants nor potted plants showed harmful effects from treatments with P-40, even at the high dosage rate.

Samples of soil and plant material were taken monthly from the P-40 treated carnation plants for selenium analysis. The analytical work on these samples has not been completed sufficiently for a report at this time.

It is of interest to note that composted soil used at the Waltham Field Station shows an analysis about 1 to 1½ p.p.m. of selenium. Tests of black swamp peat from the Station farm show that 1 to 2 p.p.m. of selenium occurs in this soil. Soil samples from market garden land near Waltham were taken for further analysis as to presence of selenium.

This project is being conducted in cooperation with the Department of Agronomy and the Waltham Field Station entomologists.

**Breeding for Varietal Improvement of Geraniums.** (Harold E. White, Waltham.) Two seedling geraniums, derived from inbreeding and hybridizing of commercial varieties, have been named and are being introduced in 1948-49.

The seedling named Dorothy is a cross between Salmon Ideal and Beaute Poitevine. It is a vigorous grower, is salmon pink in color, has large flower trusses, and blooms freely in winter or summer. The flower color does not fade under high temperature conditions of summer.

The second seedling has been named Annette and was obtained by selfing the variety Salmon Ideal. This variety has bright red flowers, is a vigorous plant, blooms very freely, and retains its flower color under high temperature conditions.

These new varieties have been compared with commercial varieties at Waltham for three years. Stock has been released to the firm of H. J. Borowski & Sons, Inc., Norwood, Massachusetts, for propagation and will be introduced to the trade in the fall of 1948.

Sufficient stock of the varieties has been retained by the Waltham Field Station to perpetuate the strains.

**Insulation of Flower Shipping Boxes.** (Harold E. White, Waltham.) In October, 1947, a new plastic material was obtained from the Dow Chemical Company, Midland, Michigan, to determine its adaptability as an insulant for flower shipping containers. This material was supplied in especially cut boards 1 inch and  $\frac{1}{2}$  inch thick for liners to be fitted inside shipping boxes. The product, known as Styrofoam, a plastic, multicellular foam produced by expanding polystyrene 40 times, is snow white in color.

Styrofoam (Type 103.7) has a thermal conductivity K factor of 27-30, is resistant to moisture, absorbing 6 percent or less by volume. Also it is resistant to fire, burning at the rate of 7 to 8 inches per minute, has great structural strength, and is very buoyant. A cubic foot weighs a maximum of 2 pounds. At present Styrofoam is produced commercially for use in refrigeration plants, lockers, storage warehouses, and railroad cars.

Cardboard shipping boxes 36 x 15 x 9 inches and 48 x 18 x 10 inches were lined with Styrofoam boards. Other boxes were lined with 10 sheets of newspaper covering the sides, ends, bottoms, and tops. Styrofoam-lined and newspaper-lined boxes were wrapped with one sheet of manila paper. Two hundred carnation flowers were packed in each box. All boxes were placed outdoors with a maximum exposure period of 18 hours. Hourly temperature readings within the boxes and on the outside were obtained by recording clock thermometers. The lowest outside temperature recorded during the test was between 11° and 12°F.

Experiments on the effect of low temperatures on cut flowers, conducted by the U. S. Department of Agriculture, show that most flowers, including carnations, are injured at a critical temperature of 28°F. or below. The shipping boxes lined with  $\frac{1}{2}$  inch Styrofoam boards dropped from an initial temperature of 62°F. to 28°F. in a period of 6 hours, whereas the temperature in the newspaper-lined box fell to 26°F. in 5 hours. The outside air temperature dropped to 12°F. The lowest temperature in the Styrofoam lined box was 26°F., and in the newspaper lined box 24°F.

Interior temperature of boxes lined with 1-inch Styrofoam dropped to 28°F. in 8 hours, whereas the temperature in the newspaper-lined box fell to 28°F. in 4 hours. In these tests temperatures within boxes lined with newspapers dropped more rapidly than in boxes prepared with Styrofoam.

Styrofoam, as an insulant for flower-shipping containers, offers several desirable features, such as lightness in weight and a low moisture factor; it is a sterile medium and has a low thermal conductivity factor. It offers possibilities as an insulation material against low temperatures and as a material to protect flowers from extreme heat during shipment. Its use presents some problems such as production for this specialized field of use, the most satisfactory method of applying the lining to the boxes, and the cost of such an insulant as compared with newspaper.

**Polyvinyl Resin Geon 31X Latex as a Flower Preservative.** (Harold E. White, Waltham.) Geon 31X Latex is a water-dispersible resin which, when applied to plant material or other objects, forms a thin transparent film. Materials can be treated by dipping them in a solution of the Latex resin or they can be sprayed.

Gardenias, carnations, camellias, cymbidium orchids, geraniums, and passion-flowers were treated with 10, 20 and 30 percent solutions of the Latex. Pigmented flowers, such as red, pink, or yellow, were affected unfavorably by even the 10

percent solution and did not keep as well as untreated blooms. White flowers, such as gardenias and carnations, treated with the 10 and 20 percent solutions, showed great variability in keeping quality as compared with untreated blooms.

Treatment of gardenia flowers did not give consistent results in keeping the petals from turning brown, even for a period of 24 hours. Individual flowers within the treated lot turned brown while others remained in good condition. This reaction took place on blooms when kept under refrigeration and at room temperature. The variable response of gardenia flowers to the treatment seems to be due to physiological differences in the flowers.

Florists' ferns treated with the resin solutions kept in much better condition than untreated ferns. The treated ferns kept for a week at room temperature before the leaflets began to shed, while the check bunches were in poor condition after 24 hours. *Asparagus plumosus* treated with 10 and 20 percent solutions gave excellent results.

Passionflowers close shortly after they are cut and usually are treated with paraffin to keep them open. Treatment of blooms with Geon 31X Latex in 50 percent concentration was not effective in keeping such flowers open.

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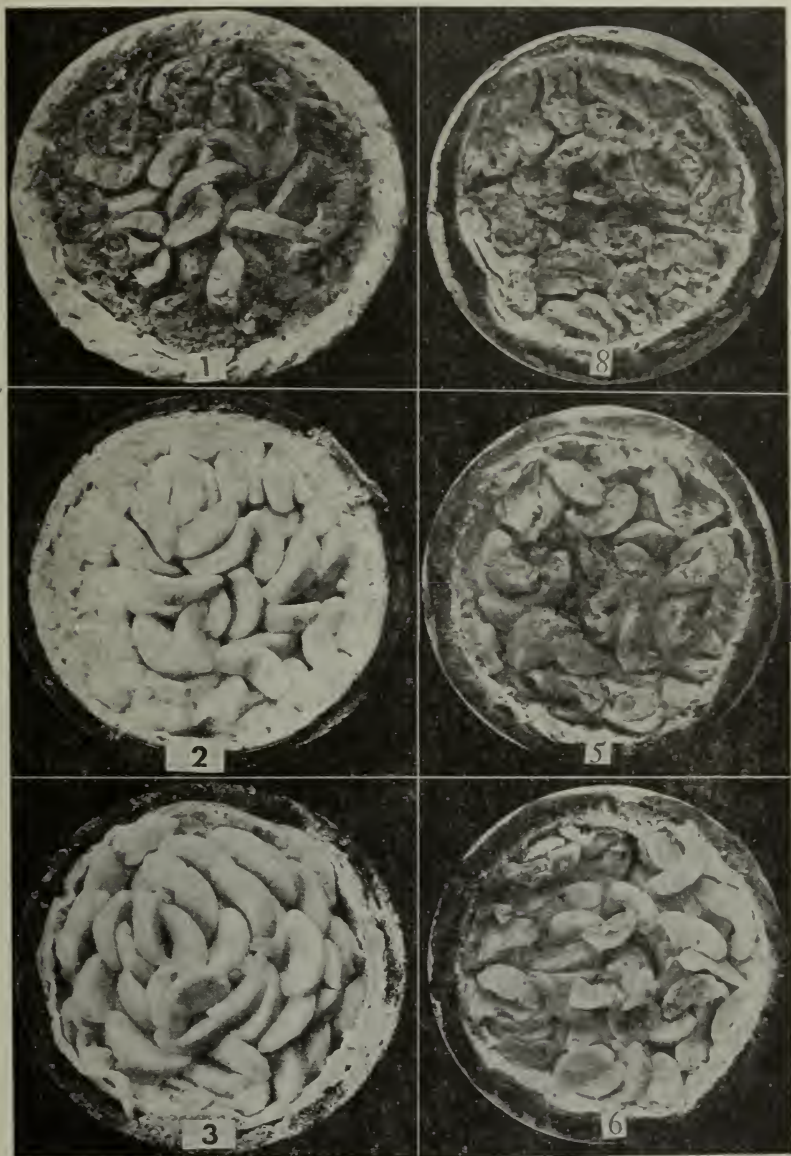
## DEPARTMENT OF FOOD TECHNOLOGY

C. R. Fellers in Charge

**Frozen Apples.** (W. B. Esselen, Jr., C. R. Fellers, and J.E.W. McConnell.) On the basis of experiments conducted here during the past three years as well as commercial experience and practice it would appear that there are several procedures which can be employed to produce frozen apples of satisfactory quality. Of the different methods used to prevent darkening, such as blanching, deaeration, sulfurous acid dips, ascorbic acid, syrups, and others, each has certain advantages and disadvantages. The selection of which anti-darkening to use may depend upon the volume of production, plant facilities, and demands of the consumer. For example, apples treated with sulfurous acid may have a residual sulfur dioxide flavor unless care and control are exercised during the operation. Blanching causes some loss of flavor and solids but does not impart off-flavors. The use of ascorbic acid can yield good results if specific procedures are followed which are applicable to the particular raw material and plant operation. The use of sugar or syrup in conjunction with ascorbic acid or other treatments may present a problem because the apples when thawed will have an excessive quantity of syrup and juice. Some consumers may object to this excess syrup as being a waste of sugar and apple flavor. On the other hand the syrup is a valuable adjunct to the frozen apples in providing protection against oxidation during freezing and thawing. It can be used effectively if it is drained from the thawed slices, concentrated, and added to the pie. Some bakers handle the sugar in this manner.

It has been frequently observed that pies made from properly prepared frozen apples were superior in fresh apple flavor and aroma to pies made from untreated fresh apples. The effectiveness of anti-darkening and antioxidant treatments given frozen apples carries through into the finished pie and tends to stabilize the apple flavor. The use of suitable antioxidants in pies made from fresh apples is worthy of consideration from the standpoint of maintaining optimum flavor.

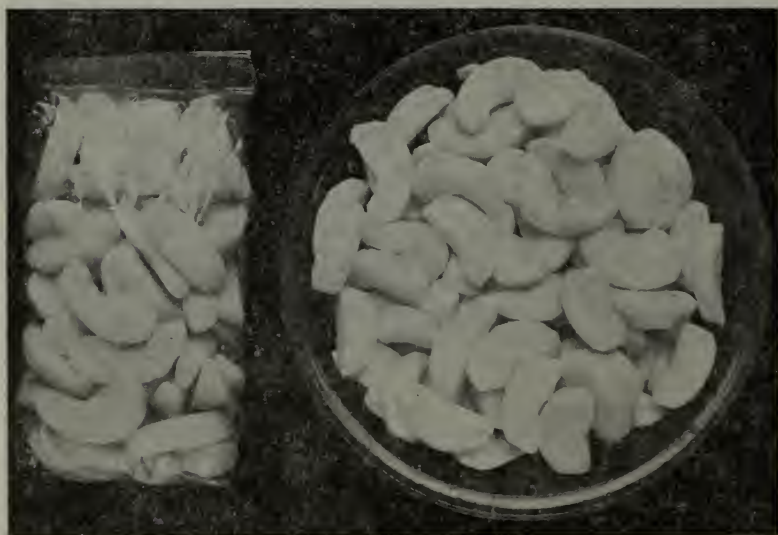




1. Pie Made from Untreated Frozen McIntosh Apples. 2. Pie Made from Frozen McIntosh Apples Treated with Sulfur Dioxide. 3. Pie Made from Frozen McIntosh Apples Treated with Sulfur Dioxide and Calcium Chloride. 4. Pie Made from Freshly Prepared Untreated McIntosh Apples. 5. Pie Made from Prepared McIntosh Pie Apples Treated with Sulfur Dioxide and Calcium Chloride and Stored for Two Weeks at Room Temperature. 6. Pie Made from Prepared McIntosh Pie Apples Treated with Sulfur Dioxide and Calcium Chloride and Stored for Three Weeks at 35° F.

**Canned and Frozen Baked McIntosh Apples.** (W. B. Esselen, Jr., C. L. Rasmussen, and C. R. Fellers.) Canned and frozen baked McIntosh apples prepared without added calcium chloride were quite soft and mushy and did not retain their shape. They retained a satisfactory degree of firmness when treated with 0.05 to 0.10 percent calcium chloride. In no instance did the calcium chloride cause an off-flavor in the product. The characteristic McIntosh flavor was well retained in both the canned and frozen apples. From the standpoint of appearance glazed apples were rated best, with vacuum-treated and core-filled apples in a descending order of preference. Scoring completely cored apples about the periphery, before baking or glazing, reduced the tendency of the skin to split. Baldwin and Northern Spy apples retained their shape and texture very well without added calcium. In fact, those treated with calcium were considered to be too firm and rubbery.

**Prepared Fresh McIntosh Apple Slices.** (W. B. Esselen, Jr., C. L. Rasmussen, and N. Glazier.) In the preparation of fresh sliced apples for the bakery or consumer trade there are several factors that must be overcome or controlled in the production and distribution of a good quality product. The objectionable browning or discoloration of the slices may be satisfactorily controlled by treatment with sulfur dioxide or for short periods of time by means of a treatment with an acid and salt solution. While the concentration of sulfur dioxide required to maintain color may vary somewhat depending upon the condition of the apples, etc., a 10-minute dip in a solution containing 1500 p.p.m. has been found to be satisfactory under our conditions. Apples treated in this manner maintained a good quality for from one to two weeks when stored at room temperature and for three weeks or longer when held at 35°F. During storage for a week or longer a considerable amount of liquid tended to leach out of the slices and accumulate in the bottom of the container.



Consumer Package (22 ounces) of Prepared Fresh McIntosh Pie Apples.

A 10 or 15 minute treatment in a solution containing 5 percent salt, 0.5 percent ascorbic acid and 0.4 percent citric or ortho-phosphoric acid gave good results if the sliced apples were to be held for only a short time. Refrigeration is essential for apple slices treated in this manner.

For soft-textured apples such as the McIntosh the addition of 0.10 percent calcium chloride in the dipping solution is effective in maintaining the texture of the slices when they are baked in pies.

**Apple-Cranberry Juice.** (W. B. Esselen, Jr., K. M. Hayes, and C. R. Fellers.) An attractive and palatable fruit juice can be made by blending from 12 to 15 percent cranberry juice with apple juice. It is necessary to give the apple juice a preliminary flash pasteurization treatment in order to inactivate enzymes which would otherwise destroy the red color of the cranberry juice when the two are mixed together prior to final processing. The enzyme present in the apple juice, which destroyed the red color of the cranberry, was inactivated by heating at 190°F. for 0.5 minute or at 180°F. for 2.0 minutes.

**Pre-Packaged Fresh Cranberries.** (C. R. Fellers, K. M. Hayes and W. B. Esselen, Jr.) A new development in the merchandising of fresh cranberries has been the packaging of the fruit in transparent bags or packages for the retail trade. During the past year a study has been made of the effect of packaging in small sealed containers on the keeping qualities of cranberries and of the various kinds of packaging material used for the storage and marketing of the fruit.

Of the packaging materials studied, single thickness 450 LSAT cellophane was found to possess the best qualities for pre-packaging fresh cranberries. This type of package had good transparency and permitted the fruit to respire slowly with a minimum loss in weight due to desiccation and respiration. Cranberries in packages stored at room temperature (65°-75°F.) could be held for five to six days without appreciable breakdown, while at 35°F. the packaged fruit remained in good condition for from four to five months. This type of package is being adopted by several cranberry marketing agencies.

**Factors Affecting the Viability of Dried Bakers' Yeast.** (R. E. Morse and C. R. Fellers.) Methods for the laboratory preparation of dried bakers' yeast were investigated. Yeast was prepared which was similar in chemical composition and leavening properties to good grade commercial dried yeast.

A new method for testing the viability of dried bakers' yeast with triphenyl tetrazolium was developed. A carmine color, developed by reduction of the dye by yeast, is extracted with acetone and measured with a spectrophotometer. Good correlation between yeast viability and color development was obtained.

Exposure to light and type of package showed little or no effect on the viability of stored dried yeast. A low storage temperature and humidity had a pronounced favorable effect on the retention of viability in dried yeast. Nutritional and environmental factors were of paramount importance in causing yeast cells to develop dormancy and longevity in the semi-desiccated state.

**The Composition and Nature of Apple Protein.** (S. G. Davis and C. R. Fellers.) Apple tissue was found to contain approximately 0.2 percent protein. Isolated apple protein material had a nitrogen content of 8.5 percent. Amino nitrogen amounted to 93.5 percent of the total nitrogen, and the 16 amino acids (leucine, isoleucine, valine, phenylalanine, tryptophane, glutamic acid, alanine, histidine, arginine, threonine, methionine, lysine, aspartic acid, serine, proline and cystine) for which values could be obtained accounted for 83.6 percent of this amount.



Notable amounts of aspartic acid and glutamic acid appeared to exist free or in the form of simple peptides or amides in the apple tissue. Tryptophane could not be detected in either the protein preparations or the apple tissue itself.

**Jar Rings for Home Canning.** (W. B. Esselen, Jr.) An investigation on the tendency of home-canning jar rings to impart off-flavors to canned foods has been completed. All natural rubber or a combination of natural and synthetic rubber (GR-S) can be used to make jar rings which will not impart undesirable flavors to foods. In using synthetic rubber it is important that the raw material be selected for this particular use. In some cases chemicals added in the fabrication of jar rings such as accelerators or antioxidants can also contribute off-flavors, particularly off-flavors characterized by a bitter taste. Apple sauce was found to be a particularly good canned food for testing jar rings. If the rings which are used to seal the jars have a tendency to cause off-flavors it will sometimes show up after three months storage at room temperature but a six months storage period prior to testing is to be preferred.

**Home Freezing.** (W. B. Esselen Jr., J. E. W. McConnell, and N. Glazier.) Work is being continued on the quality of different varieties of fruits grown in this area when frozen. The fruit varieties have been provided through the co-operation of the Department of Pomology. The products frozen during the 1947 season included 18 varieties of strawberries, 10 of blueberries, 11 of cherries, 18 of raspberries, 17 of plums, 16 of pears, 27 of peaches, and 8 of currants. A number of the varieties of frozen plums were quite attractive and flavorful but there was a tendency for many of them to have a tough skin. Frozen red currants made a very satisfactory dessert fruit. In general the frozen pears lacked flavor and were not considered satisfactory. Some variation in quality from season to season has been observed in the different varieties of frozen fruits.

**Process Times for Glass-Packed Foods.** (Cooperative project with the Glass Container Manufacturers Institute, The National Canners Association (Washington, D. C., and San Francisco, Calif., laboratories), and the California State Department of Health.) (J. E. W. McConnell and W. B. Esselen, Jr.) Experimental heat penetration data obtained with bentonite suspensions (1 and 5 percent) in glass jars of different sizes have been used in working out come-up time and cool correction factors which can be used in the application of Ball's mathematical methods for the calculation of process times for low-acid glass-packed foods. The percentage of the come-up time which may be applied as process time for glass containers corresponds very closely to the 42 percent value used for tin cans.

Under conditions of convection heating, jars appear to heat more slowly than cans of corresponding sizes. Heat penetration data indicated no difference in the heating rates of cans processed in steam and in water. In the case of conduction heating, the heating rate is somewhat faster for cans than for jars, in sizes larger than the "baby food" size. This results in a somewhat greater lethality for a given process for cans than for jars of corresponding sizes, with the exception of the "baby food" size.

It was found that rapid cooling of 5 percent bentonite in jars or cans can be brought about by high vacuum and adequate headspace. When the vacuum starts to form in the containers during the cool, boiling of the contents frequently occurs, and with this agitation of the contents, rapid cooling results.

**Tin-Treated Glass Containers for Processed Foods.** (W. B. Esselen, Jr., and Fagerson.) Glass containers whose inner surfaces had received a thin coating

of a tin compound were compared with similar untreated glass containers to determine the effects of the tin treatment on ascorbic acid, color, and flavor retentions of various foodstuffs packed in these containers. No significant differences were observed in apple juice, orange juice, asparagus, grapefruit juice, strawberries, green beans, and tomato juice, which were the foods selected for the study. The maximum amount of tin recovered from any of the foods packed in the treated containers was 5 p.p.m. from green beans which had been stored at 100°F. for six months.

Spectral studies on amber glass bottles indicated that the tin treatment did not appreciably affect the light transmission characteristics of these containers.

**The Effect of Processing Conditions of Time and Temperature Upon The Enzyme Systems of Canned Acid Foods.** (W. B. Esselen, Jr., A. M. Kaplan, and J. E. W. McConnell.) Processing times and temperatures for acid fruits, vegetables, and juices have usually been developed with the purpose of destroying or inhibiting the growth of microorganisms present in the food. With the exception of a few isolated foods and enzymes, little thought has been given to the effect of the process upon the enzyme systems involved, the assumption being that the enzyme systems are destroyed during the processing. Since it is known that enzymes play an important role in the deterioration of acid foods, the effect of heat processing on the principal enzyme systems of a representative group of acid foods was investigated. The investigation was further motivated by the possibility that the data obtained could be applied to the development of one of the enzyme systems as an indicator of adequate processing of canned acid foods.

As a result of this investigation a method has been developed for the determination of the thermal destruction conditions of the ascorbic acid oxidase and peroxidase of some acid foods that should find application in thermal destruction studies of the enzyme systems of other foods and biological systems. Thermal destruction curves of the enzyme systems studied follow a straight line within certain temperature limits when plotted on semi-logarithmic paper and are affected by some substances that are added to foods during canning. The processing requirements of time and temperature necessary to inactivate the peroxidase of experimental packs of acid foods processed under practical conditions can be accurately determined through the use of standard methods of process time determinations.

**Influence of Food Ingredients on the Heat Resistance of Spoilage Organisms Encountered in Canned Acid Foods.** (E. E. Anderson and W. B. Esselen, Jr.) Thermal death rate characteristics of suspensions of selected yeasts and bacteria were observed as they were affected by changes of the pH of the media from 3.0 to 7.0 and by various concentrations of salt (1 to 8 percent). At 140°F. the end-point of destruction (99.99 percent) of a suspension of *Saccharomyces cerevisiae* occurred within seven minutes in McIlvaine's buffer at pH 3.0. At pH 7.0, 40 percent longer time was required to accomplish the same degree of destruction.

Salt (NaCl) added to tomato juice in concentrations ranging from 1 to 8 percent caused a definite drop in pH, amounting to 0.4 to 0.5 pH units in the case of 8 percent added salt. An increased rate of destruction at all test temperatures (200° to 220°F.) was noted for suspensions of *Bacillus thermoacidurans* in tomato juice with added salt, particularly that containing 8 percent salt, in which case 99.99 percent destruction at 212°F. was effected in 60 percent of the time required by control suspensions in plain tomato juice.

**Sterilizing Value of Come-Up Time in Processing Home-Canned Foods.** (J. E. W. McConnell, N. A. Vanasse, and W. B. Esselen, Jr.) Preliminary in-

vestigations have been carried on to determine the percentage of the come-up time which may be applied as process time for home-canned foods processed in a pressure canner at 240°F. The time required, after the completion of the venting period, for the pressure canner to reach the desired processing temperature was taken as the come-up time. Come-up times ranging from 0 to 60 minutes were studied. The test media used were 1 and 5 percent suspensions of bentonite, representing convection and conduction heating products, respectively. Pint home-canning jars were used as containers. With 1 percent bentonite suspensions, 30 percent of the come-up time was equivalent to process time at 240°F.; while 50 percent of the come-up time could be applied as process time in the case of 5 percent bentonite. The effect of the come-up time on the length of the process time was independent of the pressure canner load and of the rate of cooling in the jars.

**Trimethylamine Production as an Indication of Spoilage in Fish.** (C. R. Fellers, and D. Anderson.) The effect of temperature on trimethylamine production in samples of swordfish stored at 75°F., 40°F., and 32°F. was studied. Trimethylamine formation decreased with a decrease in storage temperature. A correlation of trimethylamine and ammonia formation was noted only at the highest storage temperature used. No correlation was observed between trimethylamine and bacterial content.

A method was perfected for obtaining sterile fish muscle press juice, which was used as a medium for determining that chemical autolysis occurring in fish muscle did not reduce trimethylamine oxide to the amine. Fifty microorganisms isolated from spoiled fish muscle were tested for the trimethylamine oxide reducing characteristic. Those microorganisms which reduced the oxide were identified as members of the coliform group.

Chemical dips of a 0.3 percent solution of sodium benzoate and a 0.2 percent solution of sodium nitrite inhibited the formation of trimethylamine. Acetic acid and sodium chloride dips did not affect trimethylamine amine formation in swordfish muscle.

**Stability of Color in Fruit Juices.** (J. E. W. McConnell, E. A. Nebesky, and W. B. Esselen, Jr.) The effect of length of storage, and the relationship of oxygen, light, sugar, pH, and ascorbic acid to deteriorative changes in the color of seven representative fruit juices (blueberry, currant, raspberry, tomato, grape, strawberry, and cherry) and strawberry fountain syrup have been investigated. Similar studies were made on solutions of purified anthocyanin pigments isolated from strawberries and currants to observe whether deteriorative changes in juices of these fruits were directly associated with changes in the pigment.

Temperature of storage and oxygen content were the agents most responsible for deterioration of color during storage of both juices and isolated pigments. Exposure to light caused little deterioration of color in the juices, but exerted a measurable bleaching effect on the isolated anthocyanin pigments. Adjustment of pH values had little effect on deterioration of color in fruit juices, but some effect could be observed in solutions of isolated pigments. Sugar had little effect on stability of color in either juices or pigment solutions. The addition of l-ascorbic acid (50 mg. per 100 ml. of juice) had no protective effect on color stability with any of the juices except blueberry and grape. Addition of similar concentrations to strawberry anthocyanin, resulted in virtually complete decolorization of the pigment.

**The Non-Enzymatic Browning of Foodstuffs.** (W. B. Esselen, Jr., V. Lewis, and C. R. Fellers.) A study was made of some of the reactions that result in the



browning of foodstuffs. A method was evolved for the determination of carbon dioxide production in foodstuffs and in reaction mixtures. All foodstuffs examined produced carbon dioxide spontaneously on incubation. Some of the melanoidin pigments resulting from the reaction between glucose and glycine were isolated, and the degree of pigment production in this system correlated with carbon dioxide production. The Maillard type of reaction was not restricted to amino acids, but reactions of a similar nature were found to occur between glucose and carboxylic acids in general. Oxygen was found to be an important factor in the development of color, and sulfur dioxide was an effective inhibitor of browning. Color produced as a result of caramelization was insignificant as compared with the glucose-carboxylic acid reaction.

**The Preservative Effect of Mustard on Fruit Juices.** (S. G. Davis, Omer Kosker, and C. R. Fellers.) An investigation was conducted to study the preservative effect of mustard on fruit juices. Apple and grape juice were selected as test media and the relative effects of the active principles of common mustard seeds were investigated as well as of synthetic and natural oil of mustard. The minimum amount of mustard and mustard oil necessary for preserving the juices at varying temperatures was determined. The changes in chemical composition of the juices, as well as in their flavor and appearance, occurring under varying storage conditions were also investigated.

The inhibitory effects of mustard and mustard oil on typical spoilage organisms were determined by inoculating the sterile juice with typical spoilage organisms.

The active principle of mustard, allylthiocyanate, had definite preservative effect on the fruit juices tested.

**Processing Methods for Home-Canned Fruits.** (Cooperative Project with the Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture.) (W. B. Esselen, Jr., and N. W. Desrosier.) Heat penetration data on home-canned fruits obtained during the summers of 1945 and 1946 were analyzed, and a theoretical "run" representing the slowest heating and the fastest cooling characteristics was established for each of the following products, in pint and quart jars, for water bath and for 1, 5, and 10 pounds steam pressure processing: rhubarb, strawberries, cherries, raspberries, blueberries, peaches, apple sauce, tomatoes, and tomato juice.

Preliminary work showed that the use of pressure processing of fruit products significantly reduced the processing time required to yield a given sterilization value. The use of 1 pound steam pressure in place of water bath processing reduced the process times 25 to 35 percent, higher pressures decreasing the process to partial "come-up times." This is due to the lethality of temperatures over 212° F., when based on organisms with  $F_{212}$  of 1.0 or less.

Work with water bath processes showed that the use of high initial temperature (160°-170°F.) in comparison with temperatures in the range of 100°F. reduced the process times 50 to 75 percent.

The fruits processed under 1 pound steam pressure were organoleptically superior to those processed for greater periods of time in the water bath, both yielding the same sterilization value.

**Home-Canned Baked Beans, Hominy, and Irish Potatoes.** (Cooperative Project with the Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture.) (W. B. Esselen, Jr., N. Vanasse, N. W. Desrosier, and A. Sizer.) Work is being carried on to obtain information on the process time requirements for home-canned baked beans, hominy, and Irish potatoes

packed in pint and quart glass jars and No. 2 and No. 2½ tin cans. During the past year data on heat penetration, inoculated pack, and thermal death time were obtained for these products. The work is being checked and expanded this year in order to have additional information upon which process times may be based.

## DEPARTMENT OF FORESTRY AND WILDLIFE MANAGEMENT

R. P. Holdsworth and R. E. Trippensee in Charge

**The Effects of Growth Rate and Wood Density of Plantation-Grown Red Pine on Certain of its Properties and Uses.** (James M. Ring and J. H. Rich.) During the summer of 1947 field observations were made in 35 plantations of Red Pine located in New York, New Hampshire, and Massachusetts. Thirty-four samples of pole size were taken from eight of these plantations and one natural stand. Sections ten feet long were subjected to transverse bending tests, and the results were correlated with growth rates. The purpose of the study was to determine the feasibility of shortening the rotation without sacrificing the strength properties of poles.

Results obtained indicate that plantation-grown Red Pine which has made rapid growth during early life, and which has later slowed down forming a shell of dense growth has equally high strength, for use as poles, with Red Pine which has grown slowly from the beginning.

Spacing in plantations can be used to control rates of growth. It was further concluded that Red Pine grown in wide spacing producing low density cores results in stems more free of sweep and crook, and therefore more desirable for poles. This study was supported by the American Creosoting Company.

**Gray Squirrel Damage to Lead-Covered Telephone Cables.** (Paul A. White.) This work has been carried on since March 1946 and financed by the Bell Telephone Laboratories of New York.

The problem was to find the cause of gray squirrel damage to lead-covered telephone cable and if possible to find a way of preventing the damage. The research was carried on mostly with caged squirrels, but field checks were made in locations of damage, and data collected by the various telephone subsidiaries were analyzed and evaluated. The results of the study indicate that the attack on the cable is due to a nutritional disorder which is similar to the condition in cattle known as depraved appetite. This is caused by lack of calcium and phosphorus in the diet.

It is also possible that lead acts as a partial substitute for the calcium in the diet of the squirrels. The time of damage, of which there are two peaks, seems to indicate that the damage is related to pregnancy or lactation of the adult squirrels or to the time when the squirrel broods begin to feed for themselves.

Of the numerous repellents and cable protectors tried, Glass Fiber Cloth Tape seems to hold the greatest promise.

**Pheasant Physiology.** (Herman Goodell.) The purpose of this project was to determine whether a strain of pheasants could be developed to meet the needs of growers attempting to raise pheasants for meat.

Pure Mongolians and a Mongolian-Chinese ring-necked cross proved to be less nervous and slightly larger than straight Chinese ring-necked birds.

Sexing of day-old pheasant chicks was successfully accomplished. A pen of eight caponized males did not develop faster than did a pen of normal males handled under similar conditions.

No successful way was found to detect fast-developing birds through the inspection of plumage at an early age. There was enough variation between the development of different individuals to indicate that larger and faster growing birds could be produced.

**Seeds in Relation to Rodents.** (R. E. Trippensee.) The destruction of tree seeds by rodents prevents the establishment of stands of many trees, both softwoods and hardwoods, by direct seeding methods.

In this experiment, tests were run with pelleted pine and spruce seeds to which forty different chemicals had been incorporated as part of the series of coatings. The list of chemicals used can be furnished on request.

Concentrations of repellent substance varied from 1 to 5 percent. The trials were run with gray and red squirrels, chipmunk, and pine, meadow, house, and white-footed mice. The pelleted seeds were fed in special cages in which the feed was placed in a glass feeding receptacle. No other feed was available during the feeding trials. The test animals were given normal food after intervals of about three days.

These trials indicated that different rodents react differently, but in general none of the forty repellents gave much promise of protecting tree seeds from the rodents tested.

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## DEPARTMENT OF HOME ECONOMICS NUTRITION

Anne W. Wertz in Charge

**The Effect of Certain Factors in Wilson's Liver Fraction L on the Utilization of Thiamine.** (A. W. Wertz, L. E. Lloyd, and P. Shaw.) The widespread use of crystalline thiamine in the food-fortification program lends importance to the question of whether the utilization of thiamine may be influenced by other members of the vitamin B-complex. A norit eluate preparation which contained, in addition to pteroylglutamic acid, other factors in the vitamin B-complex was prepared from Wilson's Liver Fraction L. Albino rats fed this preparation stored more thiamine in their tissues than their pairmates which did not receive the eluate preparation but were fed identical amounts of thiamine. The urinary output of thiamine and pyruvic acid did not differ significantly in the two groups. These facts indicate that there was some factor present in the norit eluate preparation that influenced the storage of thiamine in the albino rat. Work is continuing on this project in order to determine, if possible, the factor responsible for this effect on thiamine.

**The Effect of Pteroylglutamic Acid on the Appetite and Growth of Thiamine-deficient Rats.** (P. Shaw and A. W. Wertz.) Preliminary work indicates that pteroylglutamic acid stimulates the appetite and growth of rats fed a thiamine-deficient ration. The rats fed pteroylglutamic acid consumed their food in a much shorter time and maintained their weight at a higher level than their litter-mate controls not receiving this vitamin. Further work is in progress on this problem.

**The Effect of Alcohol Consumption on the Utilization of Thiamine.** (L. E. Lloyd, P. Shaw, and A. W. Wertz.) The similarity between alcoholic polyneuritis and the polyneuritis caused by thiamine deficiency suggests the hypothesis that



the metabolism of alcohol in the body increases the need for thiamine. An experiment was designed to test this hypothesis, using albino rats as the experimental animal. Results indicate that the tissues of the rats receiving a daily supplement of alcohol contained more thiamine per gram than the tissues of their littermate controls which were fed an iso-caloric ration containing the same amount of thiamine but no alcohol. Also, the group receiving the alcohol excreted less pyruvic acid in their urine than the controls. These facts indicate that the rats receiving the alcohol were in a better state of thiamine nutrition than the rats not fed the alcohol, and that the consumption of alcohol did not increase the need for thiamine. Work is continuing on the project.

**The Nutritional Status of Pregnant Women.** (A. W. Wertz, P. Shaw, M. E. Lojkin, and E. Morse.) This project is being carried out in cooperation with the Northeast Regional Cooperative Project, Studies in Nutritional Status, and with the cooperation of Dr. E. M. Holden of Amherst. An attempt is being made to determine the nutritional status of pregnant women by studying their dietary habits and physical condition, and the quantity of certain nutrients in their blood and urine. This project is also concerned with the determination of the most suitable methods for use in studies on nutritional status. This project is to be continued for approximately three years. No results are as yet available.

**The Amount of Certain Nutrients in the Cord Blood in Relation to the Amount of these Nutrients in the Pre-natal Maternal Diet.** (A. W. Wertz, M. E. Lojkin, and P. Shaw.) This project is being carried on with the cooperation of Dr. E. M. Holden of Amherst. At parturition samples of the cord blood are obtained and the serum analyzed for protein, ascorbic acid, thiamine, riboflavin, niacin, vitamin A, and carotene. The amounts of these nutrients found in the serum are compared with the amounts present in the pre-natal maternal diet and any correlation noted.

**The Validity of the Values in Food Composition Tables for Use in the Calculation of Nutrients in Specific Diets.** (M. E. Lojkin, P. Shaw, E. Morse, and A. W. Wertz.) Food composition tables are used extensively for the calculation of the adequacy of dietaries in respect to specific nutrients, especially vitamins and minerals. As these tables are compiled from experimental results obtained all over the United States, it is pertinent to know whether the tables are valid for calculation of dietaries in Massachusetts.

A composite sample of a day's food intake is analyzed in the laboratory for protein, fat, thiamine, riboflavin, niacin, ascorbic acid, vitamin A, carotene, calcium, phosphorus, and iron. The analytical results are compared with the values obtained by calculation of these nutrients from the table of food composition. The degree of agreement or discrepancy in the figures is noted. A suitable number of dietaries will be analyzed in order that statistical methods may be applied in the interpretation of the result.

**Rodenticide Investigations.** (L. R. Parkinson.) Studies are under way to investigate the reason for the variation in the resistance of rats to red squill. Early results indicate that this variation may be due largely to the nutritional status of the rats. Heredity may also be an important factor. The apparent seasonal variation in the toxicity of alpha-naphtha-thio-urea (ANTU) is also being studied.

## DEPARTMENT OF HORTICULTURE

Clark L. Thayer in Charge

**Study of Herbaceous Perennial Material.** (C. J. Gilgut, Waltham.) The test garden of herbaceous perennial flowering plants was visited throughout the season by many people from Massachusetts and from other States. It will remain in its original location now that another site has been chosen for the proposed new laboratory and administration building.

A good blanket of snow, soon after the ground froze in the fall and during the winter, protected the plants so that few were lost by winterkilling. Some replacements of plants lost for various reasons, and of old varieties superseded by newer and more desirable varieties in the trade, have been made; but much more replacement needs to be done, especially of *Hemerocallis*. Already a good start has been made on a collection to include in this group of plants the newer colors such as reds, pinks, apricots, and bicolors, and also plants of better habit and more garden value.

A buyer of phlox plants at present has no assurance that he will receive true to name or even good phlox. On one order of eight named phlox from a mail order nursery doing business nationally, six plants were the same—a worthless, small-flowered, magenta-colored scrub seedling. Similar mixtures and also misnamed plants have been received from other nurseries.

The *Delphinium* collection has been augmented by addition of several strains and by selections from our own plantings.

Foliar nematode is a serious pest of outdoor chrysanthemums and the effectiveness of sodium selenate in several forms, varying dosages, different methods and time of application, as well as spraying at weekly intervals with wettable DDT powder were tested. The results were inconclusive and the test is being repeated this year.

**Control of Weeds in the Nursery by Chemical Sprays.** (C. J. Gilgut, Waltham.) Sovasol No. 5 was found to be a more desirable and effective weed-killer in the nursery than 2,4-D ester formulations (Weedone, Weed-no-more 40, Weeded, and Esteron) or the ammonium and sodium salts of the 2,4-D acid with which it was compared. It killed grass and other weeds quickly and, when properly controlled so that the spray did not strike nursery plants, caused no injury. Concentrations of 2,4-D necessary to kill grass caused delayed injury to nursery plants, sometimes serious, from direct spray as well as from drift of vapors of the volatile ester formulations, especially in hot weather.

Early-season applications of Sovasol No. 5, when weeds were 4 inches high or smaller, often gave weed control for as long as six weeks. In several cases two or three applications were sufficient for the season, but in most cases applications were needed at intervals of about four weeks. Late March and early April applications, when temperatures were 60° F. or less, gave good weed kill but not as good nor as quick as later in the season when temperatures were above 70° F.

In a nursery block of large plants, 5 to 6 feet high, large weeds were killed by first scything and then spraying with Sovasol in hand sprayers at one-third the cost of hoeing.

Spraying rows of gladiolus corms and cormels at the first sign of emergence of shoots through the soil gave excellent results and eliminated the first hand weeding. The spraying was done with a 3-gallon pump-up hand sprayer, and the spray applied at a moderate walk, as compared with hand weeding done tediously and always on hands and knees. Hand weeding was necessary after the plants were up because gladiolus is easily injured by Sovasol.

**Factors Influencing the Rapidity of Growth of Nursery Stock.** (C. J. Gilgut, Waltham.)

*Rhododendron Leaf Bud Cuttings.* Leaf bud cuttings of *Rhododendron roseum elegans* taken in November rooted 87 percent by May, of which 58 percent had very good roots; 16 percent good, and 13 percent fair. Lined out in the field, these plants have grown to fine salable 2-foot plants in three years. Best rooting was of cuttings from firm current wood treated with Hormodin No. 2 powder and placed in horticultural peat moss or Sanisoil (shredded redwood bark). Care was taken that the peat moss was kept moist but not wet. Other highly desirable varieties of named evergreen rhododendrons did not root well under combinations of conditions and treatments tried.

*Effect of pH, Nitrogen, Phosphorus and Potassium on Growth of Yews.* The preliminary work was carried on in pots in the greenhouse and treatments were as reported in 1947. This year the same treatments were given plants in the field. As yet there are no clear-cut results.

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## DEPARTMENT OF OLERICULTURE

G. B. Snyder in Charge

**Asparagus Investigations.** (Robert E. Young, Waltham.) The year's results with the second generation lines of asparagus breeding material showed a continuation of the biennial bearing effect reported in 1946. The crop was very poor, being 25 percent below that of the previous year but only 6 percent below that of 1945. The relationship between the selected strain and the commercial strain remains the same as previously reported. No rust appeared on any of the plants.

The nineteen strains and varieties of asparagus that make up the third generation planting were cut for the first time for two weeks in 1947. Although the cutting period was short, the yield, comparatively considered, was good. The best strain produced .36 pounds of asparagus per plant. The yield of the two commercial strains was only half of this. There was a similar range in the size of spears, from 19 to 28 per pound. While the highest yielding strain happened to be the one producing the largest spears, in general there did not seem to be a very close relationship between size of spears and yield. The strains which produced small spears came from parents that had a record for high yield but small spears.

There existed a good relationship between the number of stalks produced in the summer and the number of spears harvested. The relationship between the stalk counts and weight of spears was not as good as in previous crops.

Only 14 plants died during the year as compared with 46 the previous year. Some strains still have 100 percent plants while others have lost as many as 15 percent. This seems to be an hereditary character.

**Vegetable Breeding for Improvement of Quality.** (Robert E. Young, Waltham.) During the year breeding work was conducted with broccoli, celery, New York type lettuce, greenhouse tomatoes, trellis and field tomatoes, carrots, cabbage, and Butternut squash. Progress has been made in the development of strains of lettuce and cabbage better adapted to local use. Work was along the lines previously indicated, but new developments are not conclusive enough to warrant detailed report at this time.



*Carrots*.—During the year a search was made to find a carrot variety which would have better color than the Hutchinson but still retain the strong top, resistance to carrot blight, and, of course, the long slim root. Fifty different varieties and strains were collected from many seedsmen in both the United States and Europe. These varieties were grown as spring, summer, and fall crops.

The nine varieties obtained from Europe either were too short or produced light-colored roots. The various strains of Imperator, which is the variety grown in the West, produced a weak, small top when grown in New England. In our soil the roots of this variety are not as long as those of Hutchinson. The color is good but the tops are very susceptible to carrot blight. All of the other varieties failed to meet the standard in one way or another.

Since no variety was found to replace the Hutchinson, the breeding program to produce better-colored roots, which has been under way, will be enlarged and intensified. Roots that most nearly fit the standard were produced from material that came from crosses of Hutchinson and Turkey Red or Imperator. Considerable testing is necessary to determine adaptability, resistance to disease, and market acceptance.

*Broccoli*.—Spring and fall broccoli trials again indicated that Waltham No. 7 is suited for planting in the spring, while strain No. 29 must be grown in the fall so that the plant can develop during warm weather. Waltham No. 11 has proved adaptable for both spring and fall growing.

During the late fall of 1947, the weather was such as to demonstrate the value of strain No. 29. It is slow growing and does not easily push up to flower. Production averaged slightly more than 1 pound per plant.

There was wide variation among the many varieties in the trials to freezing damage. On some varieties 70 percent of the crop cut November 3, 1947, following a sharp freeze, was unmarketable; Waltham No. 11 had 55 percent not marketable; and Waltham No. 29 only 22 percent. This hardiness factor is important since the harvest continues well into late fall.

In 1948, cold wet weather for several weeks following transplanting of the spring crop to the field caused the plants to produce a small button of a head before obtaining their proper size. Subsequent warm weather caused these small buds to push up rapidly, forming either a worthless head or one only about one-fourth the usual size. This is the first time in ten years that the weather has been so adverse as to affect almost all varieties and strains. Waltham No. 7 made the most rapid recovery and proved the best. In 1947 it produced 1.1 pounds marketable broccoli per plant and this year only 0.77 pound. Waltham No. 11 produced 1.0 and 0.62 pound respectively for the same periods.

*Celery*.—The fifth generation of plants from a cross between Summer Pascal and Cornell No. 19 was grown. Fifty single-plant selections from the 1945 crop were tried. Along with these were trials of stock seed lots of our strain of Summer Pascal, and Summer Pascal from various seedsmen as well as new varieties recently introduced.

None of the new varieties was as good as Summer Pascal under our conditions. From the breeding material, four lots of green and one of semi-green proved sufficiently good to warrant further trial.

On some types of soil Summer Pascal has been too short, and one selection was made of a taller type to fit this need. One selection was made on the basis of its performance in the hotbed where the crop is left for early maturity. The other two have other points of superiority over Summer Pascal. Trials over several years are necessary to prove adaptability.

*Trellis Tomatoes.*—In order to bring the highest prices on the Boston market, tomatoes must have the following characters: (1) firmness, not only while ripening but when completely ripe; (2) smoothness and uniform size; and (3) uniform, deep red color. Not only do tomatoes with these characters meet with acceptance in Boston, but other New England cities and New York City have paid premiums for such fruit.

Trials of tomato varieties and hybrids have been judged with the firmness character in mind. Results indicate that many hybrids, while satisfactory in other respects, do not meet the firmness requirement. Crosses between Trellis No. 22 or Waltham Forcing and such varieties as Bonny Best, Stokesdale, Earliana, and Pritchard produced fruit that was too soft. Red Cloud, Harkness, Michigan State Forcing, and Quebec No. 5 have proved fairly satisfactory as parents.

The average early yield (first three pickings) of 10 hybrids was 3.94 pounds per plant compared to 2.78 from Trellis No. 22. Where the plants were not trellised but grown flat, the hybrids showed to better advantage. Trellis No. 22 X Red Cloud produced 5.91 pounds of fruit per plant compared to 2.39 from Trellis No. 22. This hybrid is probably sufficiently firm to satisfy the market.

Two new varieties showed to sufficient advantage to warrant recommending them to growers for trial. These are Quebec No. 5, from Laval University, Quebec, and Early Trellis, a sister selection of Trellis No. 22.

Waltham Scarlet, a variety for the home gardener and roadside stand operator that was released last year, proved to be earlier than in previous trials, being equal to Trellis No. 22 when trained up and 75 percent as good when grown flat. Total yields under both methods of culture were about equal to those of Trellis No. 22. Its advantages are larger size and better interior color and texture, while still retaining most of the firmness of Trellis No. 22.

*Greenhouse Tomatoes.*—A spring crop of greenhouse tomatoes was grown for comparison of Waltham Forcing with other varieties and hybrids.

A hybrid between Waltham Forcing and Michigan State Forcing produced 10 percent more fruit than the Waltham Forcing. While this increase in yield is sufficient to justify continued interest and trial, the fact that 33 percent more of the fruit graded No. 1 is more impressive. At prevailing Boston Market prices, cash returns amounted to \$2.39 per plant for the Waltham Forcing and \$3.06 for the hybrid.

The hybrid had larger fruit, requiring 4.84 to weigh one pound as compared with 5.38 for Waltham Forcing, and more vigor, and the plants remained greener than the Waltham Forcing. Limited trials in growers' greenhouses have aroused favorable comment, and seed production will be increased so more extensive trials can be made. More information is also being obtained about the cost of producing the hybrid seed.

*Butternut Squash.*—During the year a crop of Butternut squash was grown in the greenhouse in an effort to make up for the small number of selfed fruit obtained in 1946. This crop was grown on trellis, in the same manner as cucumbers, and produced very satisfactory fruit. Even though seed was started on February 15, only a part of the crop had matured by May 25, the time for planting seed outside.

The summer crop was satisfactory as regards yield, with the best strain producing over 500 boxes per acre. Insufficient data were obtained from many lines because of inadequate stand. It was necessary to replant some rows because of failure of greenhouse-grown seed. Planting June 15 reduced the total

yield 16 percent, and the yield of No. 1 squash 8 percent, and there was a slight reduction in the number of culls, also of cracked squash. The late planting increased the percentage of crooked squash from 6.4 to 12.4 percent.

An analysis of the data indicates a complex interrelationship between the percentages of the various grades the strains produced and the weather during the growing season. In 1946 the average percentage of cracked squash was 17.1, and in 1947, 25.8 percent.

Inbred lines are being obtained that have one and sometimes two desirable characters fairly well fixed.

Storage tests were made of all inbred lines in search of material that would have lower weight losses in storage and keep for a longer time. None of the lines kept significantly better than others. Some squash within all lines kept until January 15. The average loss in weight in this period was 22 percent, not counting the loss due to disease. When the squashes were waxed with a wax emulsion, the loss in weight was reduced 45 percent. The loss in weight was further reduced (30 percent) when the squashes were wrapped in pliofilm. The wrapping was done not as a practical method of storage but as a means of investigating weight loss.

#### **Breeding Sweet Corn, Peppers, and Field Tomatoes for Massachusetts.** (William H. Lachman.)

*Sweet Corn.*—Approximately 4,000 plants were self-pollinated during the year to further stabilize inbred lines in the process of development and to increase the seed supply of lines that are homozygous. Two crops were grown in the greenhouse in an effort to speed up the program and while the fall crop was not satisfactory the early spring crop was quite successful. With supplementary artificial lighting, a crop has been grown early in the spring for three years. It is true that inbreds do not mature in their proper season in relation to one another when grown indoors but sufficient benefits have resulted from this process so that the work has been greatly facilitated. One large seed producer in Idaho has cooperated in testing our inbreds in the production area, which has also proved to be a valuable adjunct to the project.

Ten extra early inbreds are now ready for testing in hybrid combination. These have been produced through back-crossing extra early types with later, more desirable, market types. A program of eventually combining sixteen superior inbreds into one hybrid has also been initiated. When this has been accomplished the potential mixture of germ plasma should provide some very desirable types upon self-pollination.

Several hundred experimental hybrids were grown and studied as to their general adaptability for this area. Thirty-two of these were noted as being desirable and will be included for further study.

One outstanding hybrid named Pilgrim has been introduced to the trade. This is produced by crossing Massachusetts 32 with Connecticut 27, is midseason in maturity, and the plants produce an excellent yield of large attractive ears. Approximately twelve tons of seed were sold by seedsmen to farmers for production this year.

Two new hybrids will be released in 1949. One is an extra early sort resulting from a cross of Connecticut 3 and Massachusetts 2410-191. The other is a second-early, high-quality variety resulting from crossing Massachusetts 2412-2 x 2412-1 by Maine 2.

*Peppers.*—The production of sweet peppers is greatly hampered in this area by the poor setting of fruits among the standard varieties. Serious infestations



of tobacco mosaic also take their toll. Several strains of Worldbeater have shown themselves to be resistant to this disease but they are variable within these strains as to productiveness. A number of single plant selections appear to have considerable merit. Seed is now being increased so that they may be sent out for trial.

*Tomatoes.*—A number of  $F_1$  hybrids introduced by seedsmen and experiment station workers indicate that this type variety may have considerable merit. One of the hybrids developed and tested here, Pennheart by Firesteel, performed exceptionally well in the trials last year. Several selections now in the  $F_3$  generation from a cross of Bounty by Stokesdale also look very promising. One of the lesser known varieties, Firesteel, and selections from this variety were among the best of the early varieties. These plants were especially prolific and the fruits were large, solid, and smooth.

**Weed Control in Vegetable Crops.** (William H. Lachman.) The use of Stoddard Solvent as a weed control agent in fields of carrots and parsnips is now considered standard practice by commercial vegetable growers. There is a tendency to apply this material rather late in development of these crops with the result that a rather severe necrosis develops in the crown of the roots. This is particularly disturbing since these roots do not keep well in storage.

The results from studies designed to find selective weed killers for set onions have been most promising. Recently some investigators have recommended the use of a .5 percent solution of sodium pentachlorophenate for this purpose. This material was not effective in killing annual grasses, however, and the yields from these plots were the lowest among the treatments. Dinitro compounds such as Sinox and Dow Selective Herbicide were also ineffective in controlling annual grasses but did not damage the onion tops as much as the previous treatment. The yields from these plots were also significantly lower than those from the cultivated plots. Plots in which the weeds were controlled with a hand weed burner also yielded less than the checks, although not significantly so. Good weed control but with rather severe damage to onion foliage resulted from several applications of Aero Defoliant Chemical Dust (Cyanamid) at the rate of 60 pounds per acre. The average yields from these plots were also lower than from the checks although the difference was not significant. Some preliminary work with Aero Cyanate Weed Killer (potassium iso cyanate) indicates that this material is well adapted as a weed killer in the culture of onions. It is relatively harmless to onion foliage in low concentrations (1 to 2%) and is toxic to most small weeds until they have developed to about  $\frac{3}{4}$  inch high. Lamb's quarters is especially resistant to this material after it has passed the cotyledon stage.

Isopropyl n-phenyl carbamate at the rate of 5 pounds per acre was particularly effective in controlling annual grasses in a late summer planting of spinach and beets. Overwintered spinach on these plots was completely free from chickweed whereas the check plots were badly infested with this weed. In a cooperative experiment with one vegetable grower isopropyl n-phenyl carbamate at the rate of 5 pounds to the acre was very effective in controlling chickweed in a planting of early spring lettuce.

Pre-emergence application of No. 2 fuel oil prevented the growth of weeds in sweet corn for a period of 5 weeks. 2, 4-D, in pre-emergence applications to fields of sweet corn at rates of  $1\frac{1}{2}$  to 2 pounds per acre, was particularly effective in preventing growth of weeds except for smartweed which is apparently very resistant to this treatment. Post-emergence applications of 2, 4-D were ineffective in controlling grasses. Pre-emergence applications of Dow Contact Weed

Killer at the rate of 2 to 3 gallons per acre were very effective in controlling weeds in fields of sweet corn as well as snap beans. Granular cyanamid at the rate of 600 pounds per acre prevented weed growth in sweet corn for about 4 weeks.

#### The Culture and Nutrition of Vegetables. (William H. Lachman.)

1. Tomato plants mulched with manure produced fruits higher in soluble solids, nitrogen, and phosphorus than those mulched with straw or sugar cane fiber or unmulched. Plots mulched with sugar cane fiber produced lower yields than any of the other treatments, but fruits from these plots were highest in total sugars, carotene, ascorbic acid, calcium, phosphorus, and potassium. The soil in the plot mulched with manure was in the best physical condition, and the organic matter and nitrogen were higher than in the other treatments. (In cooperation with Dr. Holmes of the Chemistry Department.)

2. Defoliation in determinate varieties of tomatoes such as Pennheart is very serious just as ripening of the fruit begins. Through experiments with varying degrees of blossom removal at anthesis, it was found that an inverse relation exists between fruit load and retention of the foliage.

3. A chlorotic condition found on the older leaves of greenhouse tomato plants has been diagnosed as magnesium deficiency. Experiments using soil known to be deficient in magnesium indicate that this chlorotic condition may be alleviated by applications of magnesium sulfate or dolomitic limestone. More response from this treatment results if it is combined with a heavy application of manure. Applications of potash aggravate the chlorotic symptoms.

4. The use of a plant hormone applied as a spray was effective in increasing the early set of tomatoes. Fruits set well on flowers that had been emasculated before anthesis and were entirely seedless.

5. Automatic surface watering of greenhouse tomatoes has a distinct possibility but the proper level of soil moisture content has not been determined. A layer of sand about one inch deep on the surface of the soil was found to be of value in distributing water laterally over and through the beds.

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## DEPARTMENT OF POMOLOGY

A. P. French in Charge

**The Influence of Various Clonal Rootstocks on Apple Varieties.** (W. D. Weeks and F. W. Southwick.) Although frost reduced the 1947 crop in the large stockscion orchard, the crop was the largest to date. Eight-year-old trees of Red Spy on Malling II averaged over a bushel of fruit per tree, while trees on Malling XVI averaged less than one-tenth bushel. In general, the yields of other varieties were greater on Malling I and II than on other stocks.

Seeds of two ornamental type crabapples, *Malus sikimensis* and *Malus torinoides*, which show promise as rootstocks, were obtained from the Arnold Arboretum. Seedlings of these will be budded to several commercial varieties for testing as to their value for root-stocks.

**Lethal Incompatibilities Between Clonal Stocks and Varieties of Apples.** (W. D. Weeks.) More evidence was obtained to show that the lethal factor in McIntosh strain R can be transmitted to the congenial McIntosh strain G. It was also demonstrated that the lethal factor in strain R does not depend on

any material manufactured in the leaves. Spy 227 stock budded to strain R buds which were sheared off in November died in typical fashion the next summer. Although the trouble appears to be caused by a virus there is no evidence that it can be transmitted except by budding. New combinations of varieties or strains budded on Spy 227 reveal that Red Spy, Foster Gravenstein, Whitcomb Gravenstein, Mead Gravenstein, Rhode Island Greening, Baldwin, and Galbraith Baldwin all died in typical fashion; while Northern Spy, Milton, Kendall, Early McIntosh, and Macoun made normal growth. A paper will be published in the Proceedings of the American Society for Horticultural Science.

**Magnesium Deficiency in Massachusetts Apple Orchards.** (W. D. Weeks.) Leaf samples for chemical analysis were taken again during 1947. Analyses of the 1946 samples indicate that mature apple trees which had received 30 and 60 pounds of magnesium sulfate per tree did not have their magnesium content increased appreciably over check trees. The low magnesium content of the leaves of the 1946 samples indicates that many of these trees were deficient in magnesium but they failed to show any typical deficiency symptoms during the growing season. Analysis of the 1947 samples is not complete at this time so we do not know whether heavy soil applications of magnesium sulfate have been successful in increasing the magnesium content of mature apple trees. No typical magnesium deficiency symptoms were observed on these trees during the 1947 season.

**Influence of Chemical Treatments on Flowering and Fruiting of Fruit Trees.** (F. W. Southwick and W. D. Weeks.) Chemical thinning tests were conducted at Amherst and in three commercial apple orchards using the dinitro materials (DN#1 and Elgetol) at blossom time and the sodium salt of naphthaleneacetic acid (App-L-Set) at calyx time and two and four weeks after calyx. One test on Halehaven peaches was conducted using three dinitro materials (DN#1, DN#289, and Elgetol) at blossom time.

Although the bloom was heavy, the weather, except for the first two or three days when apple flowers commenced to open, was not conducive to a heavy set. During the bulk of the blooming period cool, rainy weather limited the extent of pollination. Under these conditions the set was not nearly as great as the bloom indicated it might be. Elgetol applied to Red Astrachan, Baldwin, and Duchess resulted in much more thinning and foliage injury than similar single or double applications of DN#1. Where the set was heavy enough to warrant thinning on Yellow Transparent, Wealthy, Duchess, and Early McIntosh, DN#1 gave satisfactory results. It no longer seems desirable to consider the liquid dinitro materials for blossom thinning of apples. In the peach test DN#289 reduced the set more than equivalent concentrations of either DN#1 or Elgetol.

Applications of 8 ounces of App-L-Set per 100 gallons of spray at calyx time eliminated the crop on Duchess apple trees and resulted in severe leaf dwarfing and distortion. Calyx applications of this material to Wealthy, McIntosh, and in some instances Early McIntosh, thinned satisfactorily at calyx time with much less foliage injury. App-L-Set appears to be more injurious to apple foliage when applied shortly after bloom than when used at the same or higher concentrations two and four weeks after calyx. Tests at Amherst and in one grower's orchard, using up to 16 and 20 ounces of App-L-Set per 100 gallons of spray four weeks after calyx on McIntosh, Golden Delicious, and Early McIntosh, show that chemical thinning can be accomplished at this late date. A treatment that can be made as late as four weeks after calyx has a distinct advantage over bloom or calyx applications, since the extent of fruit setting and the necessity for thinning can be rather accurately determined by that time. Of course, the



earlier thinning can be done the greater are the chances of obtaining desirable commercial size with the least reduction in yield and of making alternate-bearing varieties bear more uniform annual crops.

**The Nature of Winter Hardiness in the Raspberry.** (J. S. Bailey and A. P. French.) By bringing raspberry canes into the greenhouse during the winter and observing the rate at which they started into growth it was found that the raspberry had a very short rest period and that there were varietal differences. This suggested that there might be a relationship between the length and intensity of winter rest and cold resistance.

To test this possibility canes of six varieties were brought into the greenhouse at regular intervals during three winters. The varieties Chief and Latham were selected as cold-resistant varieties, Marcy and Washington as tender varieties, and Milton and Taylor as intermediate in cold resistance. It was found that the cold resistant varieties go into a deeper rest and come out more slowly than the tender varieties. A report on this work will appear in the Proceedings of the American Society for Horticultural Science.

The raspberry planting used in this work was set in the spring of 1942. The planting was divided in half. One half was given a heavy mulch of hay or straw, whichever was available, and additional mulch added annually. The other half is cultivated with a cover crop sown in midsummer. These plots were subdivided, making a total of four plots. One mulched plot receives no additional nitrogen and the other  $\text{NaNO}_3$  annually at the rate of 225 pounds per acre. One of the cultivated plots receives  $\text{NaNO}_3$  annually at the rate of 225 pounds per acre, the other at the rate of 450 pounds. Until the winter of 1947-48 there was no indication of differential winter injury between the mulched and cultivated plots. During the winter of 1947-48 there was definitely more winter injury on the mulched plot.

Since the type of mulch used results in high soil nitrates, it was thought that nitrogen supply might be a factor. However, when the data were broken down according to the four plots varying in nitrate application, there was no relation between winter injury and the amount of  $\text{NaNO}_3$  applied.

During the winter of 1947-48, freezing tests were made to determine the rate of hardening of raspberries. The only low-temperature rooms available were in a large room held at  $0^\circ\text{F}$ . for storing frozen foods and in a sharp freeze room ordinarily held at  $-15^\circ\text{F}$ . Canes of the Chief and Latham varieties were used to represent cold-resistant varieties and canes of Marcy and Washington to represent varieties lacking cold resistance. On November 18 and December 1 canes of all four varieties were severely injured by 24 hours' exposure to  $0^\circ\text{F}$ . On January 13, following a period of several days with temperature near  $32^\circ\text{F}$ ., sudden exposure to  $0^\circ\text{F}$ . resulted in less injury than in previous tests. By shutting off the ammonia and opening the door, the temperature in the sharp-freeze room was raised to  $30^\circ\text{F}$ . Lots of canes were placed in the room and the door shut. The temperature dropped to  $+9^\circ\text{F}$ . in one hour and fifteen minutes and to  $+7^\circ\text{F}$ . in 24 hours. This treatment resulted in slightly less injury than sudden exposure to  $0^\circ\text{F}$ .

Another lot of canes was brought in for test February 19. At this time there was evidence that injury had occurred outside. Exposure to  $0^\circ\text{F}$ . caused some injury, but the difference between treated and check was not great because of the injury which occurred before the canes were brought in. Exposure to  $0^\circ\text{F}$ . caused less injury than earlier in the season. The hardy varieties, Chief and Latham, withstood the temperature drop better than the tender varieties, Marcy and Washington.

**Chemical Control of Weeds.** (J. S. Bailey.) In 1946 and 1947 it was found that ammonium sulfamate and a proprietary weed killer containing sodium chlorate and a deflagration agent could be used around apple trees four years of age to control weeds. A report of this work appeared in Vol. 51 of the Proceedings of the American Society for Horticultural Science.

To see whether these materials could be used around year-old apple trees and how much, applications were made in August, 1947. Ammonium sulfamate was used at  $\frac{3}{4}$ ,  $1\frac{1}{2}$ , 3, and 6 pounds per gallon and the proprietary mixture at 1, 2, and 4 pounds per gallon. One gallon of each concentration was sprayed in a circle about 6 feet in diameter around a tree. Treatments were made in quadruplicate.

Ammonium sulfamate at 6 pounds per gallon caused the trees to lose all their leaves in the late summer of 1947. A new crop of leaves started to appear later but these trees all died during the winter. The other concentrations caused a dwarfing of the trees roughly proportional to the amount used. Also, they caused in 1948 a chlorosis of the leaves which varied from a yellowing of the margins to a yellowing of the entire leaf.

One and two pounds of the proprietary mixture caused a slight dwarfing of the trees. Four pounds caused considerable dwarfing.

Since a circle 6 feet in diameter contains an area of about 28 square feet, the quantity of each concentration applied was nearly four times the amount which would ordinarily be used.

All concentrations of both materials killed all weeds including quack grass (*Agropyron repens*). A considerable growth of clover and some annual weeds in 1948 indicate that the soil was not sterilized for any great length of time.

In the spring of 1947 experiments were started on the control of weeds in strawberry beds with 2,4-D. A comparison was made between 2,4-D acid put in solution with Carbowax 1500, the sodium salt of 2,4-D, and an ester formulation. The ester formulation appeared to be too toxic to the strawberry plants. The 2,4-D acid and the sodium salt appeared about equally effective in the control of broad-leaved weeds and the effect on the strawberry plants was slight and temporary. The sodium salt is much easier to put into solution.

In the spring of 1948 these experiments were continued and expanded. One series of plots was laid out in a renovated bed where the sodium salt of 2,4-D, isopropyl-N-phenyl carbamate, dinitro-ortho-secondary-butylphenol, phenyl-mercuri acetate, Stoddard solvent, and some combinations of these are being tried. Another series of plots was laid out in a newly set bed where the sodium salt of 2,4-D, isopropyl-N-phenyl carbamate, phenyl-mercuri acetate, phenyl-mercuri triethanol ammonium lactate, and ammonium sulfamate and combinations of some of these are being tried.

**Nutrition of the High-Bush Blueberry, Especially in Relation to Soil Reaction.** (J. S. Bailey.) Leaf symptoms, which were very similar to those produced in sand cultures by withholding magnesium, appeared on a few of the blueberry bushes in the University planting at Amherst. In order to find out whether this was magnesium deficiency and whether or not it could be corrected by application of magnesium, a series of plots was laid out on some of which magnesium sulfate at 500 pounds per acre was broadcast on the soil and on others it was sprayed on the plants.

Leaf samples were obtained from these plots before and after treatment and from normal appearing bushes in the Cape Cod section. These samples were analyzed for P, K, Mg, and Ca by Mr. C. Tyson Smith of the Feed and Fertilizer Control Service. Compared with apple leaves, the content of P, K, and Ca was

low, but Mg was not dangerously low. From July to September Ca increased, K increased in some cases and remained about constant in others, Mg changed little, if at all, and P decreased in some cases and remained about constant in others.

**Blueberry Culture.** (J. S. Bailey.) The spraying experiments for the control of mummy berry were continued through 1947. Bordeaux mixture was not effective in controlling this disease. Fermate alone gave some control, but best results were obtained when Goodrite p.e.p.s., a spreader and sticker, was added to the Fermate. P.e.p.s. alone appeared to have a little fungicidal value. A report of these results will appear in the Proceedings of the American Society for Horticultural Science. In the spring of 1948 diligent search for mummies producing apothecia was made on numerous occasions. Only one such mummy was found although numerous mummies in apparently good condition were present. In spite of the apparent absence of apothecia, a considerable number of infected berries appeared in early summer. Because of severe winter injury and the prospect of an extremely small crop, plans for continuing the spraying experiments in 1948 were abandoned.

In the spring of 1948 a commercial test of a dormant application of D-542 was tried for the control of a Lecanium scale. It appears to be effective and safe. A dormant application of D-289 was effective in controlling the scale but was very toxic to the blueberry bushes.

In July, 1947, several bushes of the varieties Cabot and Pioneer which were covered with bindweed were sprayed with the sodium salt of 2,4-D at 1,000 ppm. This one application killed the tops of the bindweed but some regrowth occurred late in the season. In the summer of 1947 there was no evidence of injury to the blueberry bushes except a slight twisting of some of the new shoots. However, in the spring of 1948 there was slight evidence that the sprayed bushes were winter injured more than adjoining unsprayed bushes.

Although the blueberry stunt disease has been present in Massachusetts for a number of years, no indication of its spreading was found until the summer of 1947. At that time evidence was found that it was spreading slowly in Plymouth County. In the early summer of 1948 a Grover bush definitely infected and a June bush which looks suspicious were found in the University planting at Amherst. These are definitely new cases and show that the disease is spreading here, too.

There are 20 U.S.D.A. selections in the University planting. Ten of these were set in the spring of 1948. Of the other ten, five, which were budded on Rubel stocks several years ago, have fruited. Of these five V-20 looks the most promising. GN-87 looks good enough to warrant further trial. F-72, R-86 and U-85 are of doubtful value.

#### Studies of Varieties of Fruits. (W. D. Weeks and Staff.)

**Apples.**—Galbraith Baldwin, a red sport of Baldwin, which originated in one of the experimental blocks, was introduced to growers and 16 eastern nurseries for their consideration. This strain shows considerable promise and both growers and nurserymen are anxious to obtain propagating wood of it.

A bud sport of McIntosh, obtained from Roger Kimball of Littleton, has been found by federal workers to be a tetraploid and offers promise as a parent for breeding.

**Peaches.**—The following varieties have been dropped from the trial list:

Hardee is not outstandingly hardy under Massachusetts conditions, and the fruit is unattractive in shape, color, and general appearance, and is poor in texture and flavor.



Duke of York is too small, too poor in quality, ripens too unevenly and is clingstone. It has nothing but earliness to recommend it and cannot compete with other varieties of its season.

Fisher has not been outstandingly hardy. The fruit ripens very unevenly, sometimes at one end first, sometimes on the outside, leaving the center hard and underripe. The quality is variable and no better than fair at its best.

Champion, although it has many fine qualities, has flesh which is too soft for shipping. Even for the back yard better varieties are available.

Polly is almost an exact duplicate of Champion. Like that old variety, it has many good qualities but the flesh is too soft.

*Blueberries.*—Among the U.S.D.A. blueberry selections which have fruited, V-20 looks the most promising. The berries, which ripen late midseason to late, are large and fine flavored and have a good blue color. However, the scar is rather large and watery and they seem rather susceptible to the mummy berry disease. The bush bears heavy crops for its size but is a bit small. Cold resistance of both wood and buds appears good.

GN-87 is good but probably not quite good enough. The berries are usually large and have had a very good blue color in most years. The scar is usually good but the flavor is often too mild. Berries ripen late and are slightly susceptible to mummy berry. The bush is vigorous and yields well. Cold resistance of buds and wood appears good.

The fruit of F-72 is very large, dark colored and tart, ripens late, and is slightly susceptible to mummy berry. The bush is moderately vigorous. The crop has been good in some years but very light in others probably as a result of spring frost.

R-86 usually produces a good crop which ripens late but the berries are small. Their flavor is fair to good and the scar is good. The bush lacks vigor.

U-85 has produced large berries but very few of them. They ripen late, are very firm, have good color and good flavor, but are very susceptible to mummy berry. The bush is only fair in vigor.

*Grapes.*—A new blue grape, the Cook, which ripens between Worden and Concord, appears to be a worthy addition to the list of blue grapes.

*Raspberries.*—The Milton red raspberry is the most promising of the New York introductions in every respect except winter hardiness. In this characteristic it is definitely inferior to Latham or Chief. Taylor is too seriously injured by virus diseases to be desirable.

*Strawberries.*—Among the newer varieties of strawberries under trial, the Midland, Temple, Fairland, and Sparkle look promising. All are good producers of better than average quality and firmness. Temple, Fairland, and Sparkle are also resistant to the Red Stele root disease. On the other hand, Robinson (Scarlet Beauty), which has been highly advertised, has not shown much promise in our trials so far.

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## DEPARTMENT OF POULTRY HUSBANDRY

F. P. Jeffrey in Charge

**Broodiness in Poultry.** (F. A. Hays and D. W. Talmadge.) The last generation in the non-broody line included 80 females. One individual exhibited broody behavior in the first laying year with but a single broody period. Most of these females have been retained to test for deferred broody behavior. This generation again demonstrated our inability to completely eliminate the broody instinct by selective breeding.

In the fall of 1947 about 80 females of different ages in the non-broody line were given prolactin injections to test for broody inheritance. Each female was in active laying and received 50 International units of prolactin intramuscularly. With very few exceptions, egg laying stopped within two days and was not resumed for 15 or 20 days. This treatment failed to initiate broody behavior in any of the birds.

Another lot of prolactin that is believed to be free of other hormone fractions is now being used to test all females in this line as a guide to future breeding operations.

**Genetic Laws Governing the Inheritance of High Fecundity in the Domestic Fowl.** (F. A. Hays and D. W. Talmadge.) Several phases of the fecundity problem have been investigated and results published during the year.

Selective breeding has considerable value in developing high and low viability lines of Rhode Island Reds. Further evidence has been presented on the inheritance of intensity of laying. Progeny testing emphasizes the scarcity of superior sires and demonstrates their importance in breeding for high fecundity. Rather extensive colorimetric studies of feather pigments in Rhode Island Reds suggest that dense feather pigmentation depends on a series of recessive genes. The decline in egg weight in warm weather is definitely associated with decreased body weight and reduced feed consumption. This decline in egg weight is insignificant in this latitude. Hatchability has been shown to decrease with increased age of parents and the decline appears to be associated in part with higher embryonic mortality.

**A Study of Fertility Cycles in Males.** (F. A. Hays and D. W. Talmadge.) Pregnant mare serum has not been effective in activating old males to high fertility in natural matings. Thyroxine gave no positive effects for the same purpose. Artificial light appears to offer possibilities and further tests are being made concerning amount and duration.

An extensive study in females has demonstrated that as viability increases fertility decreases. Apparently high concentration of the female sex hormone concerned with fertility renders the bird more susceptible to diseases such as the paralysis complex.

**Secondary and Adult Sex Ratio in Relation to Hatchability.** (F. A. Hays.) High and low hatchability lines started in 1945 have been continued and complete hatching records have been secured. The search for lethals has been continued and the first to appear was the type of chondrodystrophy first reported by Hays in 1944. There is evidence that females are likely to predominate in early embryonic deaths while males are more abundant in dead embryos from the eighteenth day on.

Considerable success has accompanied the establishment of high and low hatchability lines but further selective breeding appears to be necessary.

**Breeding for High and Low Incidence of Internal Defects in Hen's Eggs.** (F. P. Jeffrey and C. E. Walker.) Breeding results indicate that the inherited tendency to produce meat spots in fresh laid eggs is largely independent of the inherited tendency to produce blood clots. Egg shell color in the low meat spot line is now considerably lighter than in the high meat spot line.

**Breeding White Plymouth Rocks for Eggs and Meat.** (F. P. Jeffrey.) A new sex linkage relationship has been discovered in a strain of White heavies. This autosomal dominant plus the factor for silver allows the production of 100 percent white offspring when white males are mated with Rhode Island Red females.

The reciprocal mating yields red daughters (with no black in plumage) and white sons. It has not yet been determined whether this "new" factor for dominant white is identical with the well-known dominant white as found in the Leghorn, is an allele of it, or is a new independent factor.

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### SEED CONTROL

Frederick A. McLaughlin in Charge

Enforcement of the Seed Law, together with the desire of seedsmen to comply with requirements of this Act, and a growing interest of the public in good seed, has greatly increased the number of service samples sent to the seed laboratory for testing. From July 1, 1947, to June 30, 1948, 6958 service and inspection samples of seed were received and worked at the laboratory, an increase of 1105 samples over the previous year. The laboratory also received and cleaned 101 lots of tobacco seed.

Analysis of inspection samples shows that most seedsmen have complied with label requirements of the Seed Law. A large part of the violations found are technical in nature rather than flagrant.

Operation of the Seed Law is reported in an annual bulletin issued for that purpose.

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### DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

**Poultry Disease Control Service.** (H. Van Roekel, K. L. Bullis, G. H. Snoeyenbos, O. S. Flint, F. G. Sperling, M. K. Clarke, O. M. Olesiuk, and E. M. Allen.)

1. *Pullorum Disease Eradication.* During the 1947-48 testing season 605 flocks (including chickens and fowl other than chickens) were tested in 12 counties. A total of 1,272,547 chicken blood samples was tested, of which 0.10 per cent were positive. A total of 24,564 blood samples from fowl other than chickens was tested. None of these were positive. Sixteen "breaks" were detected and of this number 13 revealed less than 0.5 percent reactors. The majority of the "break" flocks were retested until the flocks obtained a negative status. Non-reacting chicken flocks numbered 476 and represented 1,185,852 birds or 97.20 percent of all birds tested.

The testing results reveal further progress in the establishment and maintenance of pullorum-free flocks. A more detailed discussion on the pullorum testing work will be given in the Twenty-eighth Annual Report of Pullorum Disease Eradication in Massachusetts.

2. *Salmonella pullorum Antigenic Forms.* During the 1947-48 testing season *S. pullorum* cultures were isolated and typed for antigenic form from 34 birds selected from 20 flocks in the State in which pullorum infection was detected by routine flock testing. Twenty-three birds from thirteen of these flocks were found to be infected with a Standard form of *S. pullorum* (IX, XII, XII<sub>2</sub>±, XII<sub>3</sub>±). Six birds from three flocks were found to be infected with a Variant form (IX, XII, XII<sub>2</sub>±, XII<sub>3</sub>±). The remaining five infected birds from four flocks yielded cultures with antigenic characteristics between those of Standard



and Variant forms and apparently were in active form variation at the time of isolation. This was supported by the fact that after several transfers on artificial media their antigenic form tended to become Standard. It is of interest to note that to date all infected flocks (including Standard, Intermediate, and Variant forms of infection) were originally identified by the Standard form antigen. Variant form infection has not been a problem in the establishment and maintenance of pullorum-free flocks in Massachusetts thus far.

Previous to March 31, 1948, twenty-seven *S. pullorum* cultures, isolated from specimens representing acute infections in nine flocks, were typed for antigenic characteristics. One culture was Variant in form. Cultures from eleven birds from two chick flocks, both of which were hatched from eggs laid by a flock infected with an Intermediate form organism, showed mixed culture forms, Standard, Intermediate, and Variant forms being found in individuals. The remaining fifteen cultures from six flocks were of Standard form.

Additional work is being done to determine the practical significance of form variation in *S. pullorum* as it affects antigenic response and agglutination reactions.

3. *Diagnostic Service.* During the calendar year of 1947, 4,627 specimens were received in 1,010 consignments, of which 660 were delivered in person. This represents a considerable increase in the number of consignments, 146 of which were for immunity tests in order that the flocks might be included in the infectious bronchitis and Newcastle disease programs. The specimens were classified as follows:- 4,116 chickens; 393 turkeys; 30 canaries; 12 canine feces; 11 each of mink, and rabbits; 10 pheasants; 6 each of fish and pigeon; 4 rats; 3 each of bovine semen, ducks, and ruffed grouse; 2 each of bovine feces, equine semen, grosbeaks, guinea pigs, and swine; and one each of bovine, bovine fetus, bovine organs, bovine pus, goat feces, meat, ovine organs, rabbit liver, and swan.

Tumors (110), coccidiosis (82), and fowl paralysis (57), which in past years have been consistently among the most common diagnoses, were displaced by infectious bronchitis (150) and Newcastle disease (115). In 113 cases of respiratory infection a definite diagnosis was not made. Avian tuberculosis was identified on two premises. Fowl cholera was diagnosed on 18 premises. Eleven of these represent new known foci of infection, and on two others there had been no evidence of infection for four and seven years, respectively. Fowl typhoid was identified in 24 outbreaks on 20 premises, 15 of which represent new known foci of infection.

The number of outbreaks of fowl typhoid during the past four years suggests that this disease, if not checked, may become a serious problem to the industry. During the past two years, each flock was visited or the owner was otherwise contacted to assist in formulating an eradication program. Agglutination tests are conducted in flocks which are not depopulated and where testing seems indicated. The flock owners are contacted during the year following the outbreak to obtain information on the success of the eradication program. Attempts are being made to inform those engaged in the poultry industry concerning the prevalence and potential dangers of the disease. Infection reappeared in 1947 on four of the 19 premises which were known to have been infected in 1946. The effort to eradicate infection on two of these premises was believed to have been insufficient. Infection on the third was believed to have been carried over in an uncleaned pig pen adjacent to the range. An explanation was not found for the reappearance of infection on the fourth premise.

A severe conjunctivitis and keratitis in young chickens was present in five consignments. This apparently is a relatively new condition as only five cases

were observed in the previous four years and five cases were observed in the spring of 1948. Affected birds were two to 18 weeks of age (average 11 weeks). The percentage of birds affected averaged about 12 percent. The birds keep the eyelids closed, sometimes manifesting marked irritation by rubbing the eyes on their wings. There is slight lacrimation with marked congestion and moderate edema of the conjunctiva. Ulceration of the cornea varies from small areas on the posterior surface to almost complete involvement. Affected birds sit quietly for one to two weeks, eating and drinking very little, with resultant rapid loss in weight. Improvement is gradual thereafter, requiring one to three months, and, in some birds, there remains some cloudiness of the cornea. The cause of the condition has not been established.

Pox was observed in two canary flocks with a resultant mortality of approximately 35 and 65 percent respectively. Available information indicates that only vaccine of canary origin is of value in immunizing canaries. Vaccine supplied by Dr. F. R. Beaudette of the New Jersey Agricultural Experiment Station was introduced into each of these flocks at a time when entirely favorable results could not be expected. The vaccination apparently influenced the course of the disease favorably in one flock and was used too late in the other flock.

The 393 turkeys were received in 77 consignments, representing about 40 percent less material than was received in each of the previous two years. Paratyphoid infection, enterohepatitis, and coccidiosis were the conditions encountered most frequently. Erysipelas, which was quite prevalent the previous year, was identified in only one case. Newcastle disease was identified in two outbreaks. The mortality in poults, apparently infected when received, was about 40 percent over a four weeks' period. In an affected breeding flock, which manifested only mild respiratory symptoms, the egg production declined approximately 50 percent and the egg shell quality was definitely affected. Field evidence indicated that the poults hatched were not affected.

4. *Flock Mortality Studies.* No significant new information was obtained in this continuation of examinations on the flock maintained at the University for genetic studies. The number of birds examined was much smaller than in previous years, reflecting in part lower mortality in the flock. Up to January 1, 1948, necropsies were made on 117 birds (92 females and 25 males) from the flock hatched in the spring of 1946. *Pasteurella avicida* was recovered from lesions of the feet of one male. The last previous isolation of this organism in the flock was in 1939 and it was not causing serious trouble at that time. No unusual disease outbreaks were noted. Reproductive disorders, cannibalism, tumors, and kidney disorders were the principal causes of mortality. Gross examination revealed lymphocytoma in only one female and one male, fowl paralysis in three females and one male, and myelocytoma in four females.

5. *Infectious Bronchitis Control.* During 1947 a total of 263 flocks was enrolled in the infectious bronchitis control program, an increase of 46 flocks over the previous season. The results continue to be satisfactory and more flock owners are beginning to realize the value of a flock immune to bronchitis. During the past year 177 flocks were tested for immunity to infectious bronchitis, 133 of which were found to be immune, 27 susceptible, and 17 questionable.

The poultry bronchitis laboratory also tested flocks for Newcastle disease. A total of 300 flocks was tested, 115 of which were found positive and 185 negative.

Thirty-six flocks were found to be positive for both Newcastle disease and infectious bronchitis. Newcastle disease was identified in all but one county

(Dukes) during 1947. Both infectious bronchitis and Newcastle disease are very prevalent in Massachusetts and represent a serious economic menace to the industry.

During 1947 a Newcastle disease immunization project was initiated. A preliminary report of the results has been published as Contribution Number 645, Massachusetts Agricultural Experiment Station. The encouraging results have permitted the development of a State-wide flock vaccination program on an investigational basis.

During the past year the viability of Newcastle virus in infertile eggs held at incubator temperature (99° F.) and humidity (wet-bulb reading 90° F.) has been investigated. Preliminary results reveal that the virus may remain viable under those environmental conditions for at least 29 days.

The resistance of the virus to formaldehyde fumigation was also investigated. Preliminary results reveal that whole egg shells with only one end broken and the outer surface contaminated with Newcastle virus require at least one hour of triple strength fumigation (105cc. formalin and 52½ grams potassium permanganate per 100 cubic feet of space, at a temperature of 99° F. and a wet-bulb thermometer reading of 86°) to destroy the virus. However, when egg shells were finely crushed and contaminated with virus, one-hour fumigation was insufficient to kill the virus.

These investigations on the behavior of the virus under various physical, chemical, and thermal influences are being continued.

**Mastitis Testing Laboratory.** (W. K. Harris.) Laboratory examination of milk samples for the diagnosis of bovine mastitis was first reported by the laboratory on samples received March 24, 1947. Following the examination of samples, group segregation of the cows is recommended according to the results of the test. The group numbers shown on the report of test and their significance are as follows:

Group I—Negative.

Group II—Positive for mastitis not due to *Str. agalactiae*. Such cases are most commonly due to infection with Staphylococci, *Str. uberis*, *Str. dysgalactiae*, or coliform organisms. This group includes cows having non-infectious mastitis.

Group III—Positive for *Str. agalactiae*.

During the period from March 24 to June 30, 1947, inclusive, 4,607 samples from 1,166 head in 21 State-owned herds were tested. Of these, 691 cows were placed in Group I, 236 in Group II, and 239 in Group III. No tests on private herds were completed during the period. During the fiscal year of 1947-48 a total of 13,645 milk samples was tested. There were 102 samples submitted that were unsuitable for testing. From cows in State-owned herds 9,113 samples, and from private herds 4,532 samples were examined. The above figures include both partial and complete herd retests.

In order to determine the incidence of mastitis in the private herds tested, a summary of the initial tests was made. Initial tests were made on samples from 1,157 head, representing 75 herds, of which 56 had less than 20 cows each and 19 had 20 cows or more. The percentage of cows found infected is shown as follows:-

	Herds	Head	Percentages in Groups			Percentage Infected
			I	II	III	
Under 20 cows	56	465	59	24	17	41
20 cows or more	19	692	47.5	19.5	33	52.5
Combined	75	1,157	52	21.5	26.5	48



It appears significant (1) that the percentage of Group III cows in the 19 herds is approximately twice as great as in the 56 smaller herds, and (2) that nearly one-half of all the cows tested had mastitis on the initial test. A study of the test results of the 75 herds revealed that 81 percent of the herds had some cows in Group II, 47 percent had some cows in Group III, and 37 percent had cows in both of these groups.

The percentage of cows having mastitis in the 22 State-owned herds was found to be approximately the same as in private herds, but a higher proportion of the cows, 38 percent, was in Group III. In Group II there were 11.5 percent. The average number of cows milked in the State-owned herds was 54, while in the private herds it was 15.

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## WALTHAM FIELD STATION

Waltham, Massachusetts

Ray M. Koon, In Charge

The members of the research staff of the Waltham Field Station are assigned to this branch by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Refer to reports of these Departments for results of investigations conducted at this Station.

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## PUBLICATIONS

### Bulletins

- 440 Apples as Food. By William B. Esselen, Jr., Carl R. Fellers, and Marie S. Gutowska. 32 pp. August 1947.

Apples owe their widespread popularity to their attractiveness and palatability. Now with recognized food values assigned to them, apples also assume importance as a "protective food" in the American diet. This bulletin summarizes information on composition and nutritive value.

- 441 Annual Report for the Fiscal Year Ending June 30, 1947. 72 pp. September 1947.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

- 442 Mortality Studies in Rhode Island Reds, II. By F. A. Hays. 8 pp. July 1947.

Mortality from all causes is one of the most important problems of poultrymen. This report gives the final results of an attempt to breed lines of Rhode Island Reds resistant or susceptible to mortality from all causes.

- 443 The Inheritance of Intensity of Laying in Rhode Island Reds. By F. A. Hays. 12 pp. July 1947.

Intensity of laying is one of the most important characters associated with high fecundity. Particular attention is given in this report to different methods of measuring intensity and to evidence regarding its inheritance.

- 444 Fertilizer Experiments on an Abnormal Orchard Soil. By J. K. Shaw. 16 pp. illus. December 1947.

This bulletin reports the response of fruit plants to a long-continued fertilizer program of nitrogen, phosphorus, potash, and lime. The conditions were unusual; but the results are of value in suggesting right and wrong fertilizer programs in the orchard.

- 446 Septic Tank Studies. By James E. Fuller. 19 pp. illus. February 1948.

This bulletin reports a study of the operating efficiency of septic tanks when sewage is retained for periods less than the 24 hours usually recommended. Management observations and chemical and biological tests gave evidence in favor of the conventional practice of holding sewage in tanks for 24 hours or more.

- 447 Cranberry Growing in Massachusetts. By Henry J. Franklin. 44 pp. illus. April 1948. (Revision of Bulletin 371.)

Massachusetts produces more than half the cranberries grown in the world. It is, therefore, considered desirable to issue a bulletin dealing with the cultural practices of this important crop.

- 448 The Valuation of Dairy Farm Property for Local Tax Purposes in Massachusetts. By Alfred A. Brown. 16 pp. April 1948.

Valuations indicate the community's estimate of the property owner's obligation to it; yet they are frequently overlooked in the constant concern over taxes. This report attempts to give to valuations the importance they deserve and to suggest ways of increasing the objectivity of the valuation process.

### Control Bulletins

- 132 Inspection of Commercial Feedstuffs. By Feed Control Service Staff. 36 pp. June 1947.
- 133 Inspection of Commercial Fertilizers and Agricultural Lime Products. By Fertilizer Control Service Staff. 20 pp. July 1947.
- 134 Twenty-Seventh Annual Report of Pullorum Disease Eradication in Massachusetts. By the Poultry Disease Control Laboratory. 11 pp. July 1947.
- 135 Seed Inspection. By F. A. McLaughlin. 33 pp. November 1947.

### Meteorological Bulletins

- 703-714, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By H. N. Stapleton. 4 pp. each.

### Reports of Investigations in Journals

#### Numbered Contributions

- 553 Immunization against a lymphoid tumor of the chicken. IV. Use of miscellaneous tests. By Carl Olson, Jr. Cornell Vet. 37 (3):231-240. 1947.
- 582 The hemicelluloses of maize cobs and rye straw. By Emmett Bennett. Jour. Agr. Res. 75 (1):43-47. 1947.
- 600 Variation in composition of winter squashes. By Arthur D. Holmes, C. Tyson Smith, and William H. Lachman. Food Res. 13 (2):123-127. 1948.
- 611 Role of kaolin in anion sorption and exchange. By Dale H. Sieling. Soil Science Soc. Amer. Proc. 11 (1946):161-170. 1947.
- 612 Some characteristics of mare's colostrum and milk. By Arthur D. Holmes and Harry G. Lindquist. Jour. Amer. Diet. Assoc. 23 (11):957-961. 1947.
- 613 The use of oil sprays as selective herbicides for carrots and parsnips III. By William H. Lachman. Amer. Soc. Hort. Sci. Proc. 49:343-346. 1947.

- 614 Pre-emergence spraying for weed control in vegetables. By William H. Lachman. *Amer. Soc. Hort. Sci. Proc.* 49:339-342. 1947.
- 615 Development time from bloom to maturity in cultivated blueberries. By J. S. Bailey. *Amer. Soc. Hort. Sci. Proc.* 49:193-195. 1947.
- 617 Stability of reduced ascorbic acid in mares' milk. By Arthur D. Holmes and Carleton P. Jones. *Jour. Nutrition* 34 (1):113-119. 1947.
- 622 Testing quaternary ammonium sanitizers as used in the dairy industry. By W. S. Mueller, D. B. Seeley, and E. P. Larkin. *Soap and Sanitary Chemicals* for September 1947.
- 623 Ascorbic acid content of hen's eggs. By G. H. Satterfield, T. A. Bell, F. W. Cook, and Arthur D. Holmes. *Jour. Amer. Dietet. Assoc.* 23 (12):1052-1054. 1947.
- 624 Male sex hormones and artificial light as activators in the spermatogenesis of adult males. II. By F. A. Hays. *Poultry Sci.* 27 (1):3-6. 1948.
- 625 Vegetative propagation of kudzu. By W. L. Doran and A. B. Beaumont. *Jour. Amer. Soc. Agron.* 39 (9):834-835. 1947.
- 626 Plumage color genes in White Plymouth Rocks and White Wyandottes. By F. P. Jeffrey. *Poultry Sci.* 26 (5):526-528. 1947.
- 627 Antioxidants in vegetable oils. By John E. W. McConnell. *Amer. Perfumer and Essential Oil Rev.* 50 (3):241-243; (4):346-349. 1947.
- 631 Further studies on the use of calcium chloride to maintain firmness in canned and frozen apples. By W. B. Esselen, Jr., W. J. Hart, Jr., and C. R. Fellers. *Fruit Prod. Jour. and Amer. Food Mfr.* 27 (1):8-13. 1947.
- 632 The freezing of swordfish. By Antonio Lopez-Matas and C. R. Fellers. *Quick Frozen Foods* 10 (3):72-75. 1947.
- 633 Thyroxine and artificial light as activators in the spermatogenesis of males. By F. A. Hays. *Poultry Sci.* 27 (1):84-86. 1948.
- 636 Permanency of synthetic ascorbic acid added to milk. By Arthur D. Holmes and Carleton P. Jones. *Jour. Dairy Sci.* 31 (2):99-102. 1948.
- 637 Viability and fertility in Rhode Island Red females. By F. A. Hays. *Poultry Sci.* 27 (2):186-193. 1948.
- 638 Extraction of copper from soil as affected by soluble components of oat straw and alfalfa meal. By Charles Hurwitz. *Soil Sci.* 65 (3):275-280. 1948.
- 641 The value of the progeny test in males. By F. A. Hays. *Amer. Nat.* 81:454-460. 1947.
- 643 Some studies using isopropyl n-phenyl carbamate as a selective herbicide. By William H. Lachman. *Amer. Soc. Hort. Sci. Proc.* 51:541-544. 1948.
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- 645 Immunization of chickens against Newcastle disease. By H. Van Roekel, F. G. Sperling, K. L. Bullis, and O. M. Olesiuk. *Jour. Amer. Vet. Med. Assoc.* 112 (851):131-132. 1948.
- 646 A Valsa associated with Cytospora canker of spruces. By David H. Marsden. *Phytopathology* 38 (4):307-308. 1948.
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- Dutch elm disease. By Malcolm A. McKenzie. *New England Council Report on Regional Meeting*, Nov. 7, 1947. pp. 6-7.
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- Pest control on ornamentals. By W. D. Whitcomb. *Horticulture* 26 (5):196-199. 1948.
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- Laboratory tests in controlling pillbugs. By F. R. Shaw, A. I. Bourne, and W. B. Hathaway. *Jour. Econ. Ent.* 39 (6):818-819. 1946.
- Control of black scale on gardenias in commercial greenhouses. A. I. Bourne and F. R. Shaw. *Jour. Econ. Ent.* 40 (3):429-430. 1947.
- Chironomid larvae in a tobacco seed bed. By F. R. Shaw and A. I. Bourne. *Jour. Econ. Ent.* 40 (5):749. 1947.
- Experiments with benzene hexachloride and similar materials on vegetables and tobacco. By W. D. Whitcomb and A. I. Bourne. *Mass. Agr. Expt. Sta. Spec. Cir. (mimeographed)* 8 pp. March 1948.
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- Controlling gladiolus thrips. By A. I. Bourne and F. R. Shaw. *Mass. Ext. Service Spec. Cir.* 16 (Rev.).

- Ants outdoors. By A. I. Bourne. Mass. Ext. Service Spec. Cir. 33 (Rev.).
- Insecticides for the control of the European corn borer in early sweet corn. By A. I. Bourne. Mass. Ext. Service Spec. Cir. 76 (Rev.).
- DDT for plant pest control. By W. D. Whitcomb, A. I. Bourne, and F. R. Shaw. Mass. Ext. Service Spec. Cir. 135 (Rev.).
- The use of DDT for control of household pests. By H. L. Sweetman and A. I. Bourne. Mass. Ext. Service Spec. Cir. 136 (Rev.).
- Processing foods in glass containers. By W. B. Esselen, Jr., M. J. Powers, C. T. Townsend, and J. M. Reed. The Canner 106 (9):16, 18, 34. 1948.
- Use of commercial dips in the preservation of swordfish steaks stored at 32° to 40° F. By A. Lopez-Matas and C. R. Fellers. Fishing Gazette for August 1947. 2 pp.
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MASSACHUSETTS:  
AGRICULTURAL EXPERIMENT STATION

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BULLETIN NO. 453

AUGUST 1949

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## Annual Report

For the Fiscal Year Ending June 30, 1949

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The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

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UNIVERSITY OF MASSACHUSETTS  
AMHERST, MASS.

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# MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

## Trustee Committee on Experiment Station

Term Expires

JAN 25 1950

BRETT, ALDEN C., Belmont, Chairman	1950
CHANDLER, JOHN., <i>Commissioner of Agriculture</i>	
HOFTYZER, ERNEST, Wellesley	1950
MCNAMARA, MRS. ELIZABETH L., Cambridge	1951
DEELY, JOHN M., Lee	1953
HUBBARD, CLIFFORD C., Mansfield	1953
WHITMORE, PHILIP F., Sunderland	1955

## Experiment Station Staff, June 30, 1949

VAN METER, RALPH A., *President of the University*

SIEVERS, FRED J., Director  
GASKILL, EDWIN F., Assistant to the Director  
O'DONNELL, MARGARET H., Associate Director

HAWLEY, ROBERT D., Treasurer  
FELTON, F. ETHEL, Editor  
MALLORY, DOROTHY E., Secretary

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ARCHIBALD, JOHN G., Animal Husbandry  
BOURNE, ARTHUR I., Entomology  
\*BRADLEY, LEON A., Bacteriology  
BROWN, ALFRED A., Agricultural Economic and Farm Management  
BULLIS, KENNETH L., Veterinary Science  
†CHANDLER, FREDERICK B., Cranberries  
COLBY, WILLIAM G., Agronomy  
COX, EARLE, Agricultural Engineering  
DORAN, WILLIAM L., Botany  
DRAKE, MACK, Chemistry  
EISENMENGER, WALTER S., Agronomy  
\*FELLERS, CARL R., Food Technology  
†\*FRANKLIN, HENRY J., Cranberries  
\*FRENCH, ARTHUR P., Pomology  
FULLER, JAMES E., Bacteriology  
\*GAMBLE, PHILIP L., Economics  
\*GASKILL, EDWIN F., Station Service  
†GUBA, EMIL F., Botany  
\*HANKINSON, DENZEL J., Dairy Industry  
HARRIS, WILLIAM K., Veterinary Science  
HASKINS, HENRI D., Agricultural Chemistry (Professor Emeritus)  
HAYS, FRANK A., Poultry Husbandry  
HITCHNER, STEPHEN B., Veterinary Science  
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HOLLAND, EDWARD B., Chemistry (Professor Emeritus)  
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\*MITCHELL, HELEN S., Home Economics  
\*OSMUN, A. VINCENT, Botany  
\*RICE, VICTOR A., Animal Husbandry  
\*RITCHIE, WALTER S., Chemistry  
ROZMAN, DAVID, Economics  
SHAW, JACOB K., Pomology (Professor Emeritus)  
\*SIELING, DALE H., Agronomy  
SMITH, PHILIP H., Agricultural Chemistry (Professor Emeritus)  
SNOEYENBOS, GLENN H., Veterinary Science  
\*SNYDER, GRANT B., Olericulture  
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\*STAPLETON, HERBERT N., Agricultural Engineering  
\*THAYER, CLARK L., Floriculture  
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WERTZ, ANNE W., Home Economics Nutrition  
†WHITCOMB, WARREN D., Entomology  
WHITE, HAROLD E., Floriculture  
WOOD, BASIL B., Library

CROSSMON, BRADFORD D., Agricultural Economics and Farm Management  
ESSELEN, WILLIAM B., Jr., Food Technology  
McLAUGHLIN, FREDERICK A., Seed Law  
SPELMAN, ALBERT F., Feed and Fertilizer Laws  
†YOUNG ROBERT E., Olericulture

ANDERSON, EDWARD E., Food Technology  
BAILEY, JOHN S., Pomology  
BECKER, WILLIAM B., Entomology  
BENNETT, EMMETT, Chemistry  
†BUTTERFIELD, NORMAN W., Floriculture  
CLARKE, MIRIAM K., Veterinary Science  
†CROSS, CHESTER E., Cranberries  
†DEMPSEY, PAUL W., Horticulture  
DESROSIER, NORMAN W., Food Technology  
FITZPATRICK, ROBERT A., Agricultural Economics and Farm Management  
FLINT, OLIVER S., Veterinary Science  
†GILGUT, CONSTANTINE J., Nurseryculture  
JONES, CARLETON P., Chemistry  
JONES, LINUS H., Botany  
KUCINSKI, KAROL J., Agronomy  
LACHMAN, WILLIAM H., Jr., Olericulture  
LOJIN, MARY, Home Economics Nutrition  
MUELLER, WILLIAM S., Dairy Industry  
SMITH, C. TYSON, Feed and Fertilizer Laws  
SPINDLER, HERBERT G., Agricultural Economics and Farm Management  
WETHERBEE, ROBERT T., Feed and Fertilizer Laws

ANDERSON, JESSIE L., Seed Law  
BARNES, GLADYS, Poultry Husbandry  
BART, JOSEPH A., Feed and Fertilizer Laws  
†BOBULA, PAUL, Nurseryculture  
BRANDT, CARL D., Veterinary Science  
BROWN, BARBARA E., Agricultural Economics and Farm Management  
BRUNDAGE, ROBERT W., Agricultural Economics and Farm Management  
†CAMPBELL, FRANKLIN, Floriculture  
CONKLIN, JOSEPH, Dairy, Feed, and Fertilizer Laws  
CROSBY, EARLE B., Veterinary Science  
CROTTY, ANN M., Veterinary Science  
§CROWLEY, LEO V., Feed and Fertilizer Laws  
†DONNELLY, EDWARD B., Floriculture  
†FRAZIER, JOHN, Olericulture  
GARDNER, GRACE, Pomology  
†GARLAND, WILLIAM, Entomology  
GOULET, FERN A., Veterinary Science  
GRADY, RUTH E., Veterinary Science  
HAGAN, GLADYS C., Home Economics Nutrition  
†HOOD, CHARLES S., Entomology  
JEWETT, FELICIA Z., Veterinary Science

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†KELLEY, JOSEPH L., Cranberries  
LAMBERT, DORIS, Veterinary Science  
LAMBSON, FRANK, Veterinary Science  
MARTELL, JOSEPH A., Dairy, Feed, and  
Fertilizer Laws  
MERWIN, CHARLES L., Veterinary Science  
MINER, GLADYS I., Botany  
MOLINE, JESSIE, Botany  
OLESIUK, OLGA M., Veterinary Science  
PARKINSON, LEONARD R., Home Economics  
Nutrition  
PIERCE, VIRGINIA J., Agricultural Economics  
and Farm Management  
REYNOLDS, IONA M., Veterinary Science  
SHAW, HAROLD R., Agricultural Economics  
and Farm Management

SHAW, PRISCILLA, Home Economics Nutri-  
tion  
SHERBURNE, RUTH E., Economics  
SPEAR, ARTHUR J., Home Economics Nu-  
trition  
STANLEY, ALBERT M., Veterinary Science  
TALMADGE, DANIEL W., Poultry Husbandry  
WARD, JEAN A., Agricultural Economics  
and Farm Management  
WEEKS, WALTER D., Pomology  
WHITE, W HENRY, Botany  
†WILSON, HAROLD A., Horticulture  
YEGIAN, HRANT M., Agronomy

\*In charge    †At East Wareham    ‡At Waltham    §On Military Leave

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# ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1948-49

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## DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

**Fluid Milk Prices in Major Northeastern Markets.** (A. A. Brown, H. G. Spindler, V. A. Reising, and J. A. Ward.) Attention has been centered on the historical relationship of prices between Worcester and Springfield, Worcester and Boston; between Springfield and Boston; and between Springfield and New York. The basic data developed for Springfield and Worcester have been obtained from reports and audits in the files of the Massachusetts Milk Control Board. The analysis of the relationship of the New York and Boston markets is being developed by the staff of the New England Research Council.

For Worcester and Springfield the following work has been done:

- (a) Prepared market summaries of receipts and sales by months for 1945.
- (b) Determined relationship between farm-to-plant transportation rates and distances from farm to plant.
- (c) Determined respective milksheds on a town basis.
- (d) Computed monthly weighted average prices paid to producers for the period 1945-1948.
- (e) Prepared and published "Selected Statistics, Springfield Milk Market (Area 6A) June and November 1948." This publication includes summaries of receipts and sales, and a computation of weighted average prices based on net utilization of receipts from producers.

Post-war difficulties are evident in the Springfield and Worcester markets. Differences in blended prices between markets, together with the wide disparity between Class I and Class II and between Class I and blended prices in each market, have been principal factors creating unstable situations. The sharp drop in the Class II prices in the fall of 1948 resulted in unusually wide spreads between the class prices and producer prices and has given rise to the problem associated with unequal costs of milk to dealers in the same market.

**Marketing of Hatching Eggs.** (A. A. Brown, B. E. Brown, and J. A. Ward.) Analysis to date of the marketing operations of broiler-hatching egg producers discloses two points that may be usefully developed. One pertains to breed; the other to alternative market outlets.

During the curtailment period that developed in the fall of 1948, about two thirds of the flock owners shipping broiler-hatching eggs received notices to discontinue or reduce shipments. Of these flock owners 79 percent had their pens mated Rock-Reds, straight Rocks, or mixtures. The balance of this group was divided between straight Reds (8 percent) and Rock-Hamps (13 percent). Among flock owners who did not receive curtailment notices pens were mated as follows: Rock-Hamp and Hamps (45 percent), Rock-Red and Reds (36 percent), other combinations (19 percent). The data indicate that when cutbacks are made in orders, shippers of Rock-Hamp or Hamps are in the least vulnerable position; but that shippers of good strains of Rock-Reds may not fare too badly.

Analysis was also made of the changes that occurred in receipts of "nearby" eggs at Boston during November and December 1948. The results are not conclusive. More detail is desirable. The data indicate, however, that the moderate



shifts that occurred in the movement of broiler-hatching eggs were highly over-rated as a cause of the break in egg prices. The situation suggests that if the small net volume involved did precipitate a downward trend, the organization and structure of the market is woefully defective.

**Egg Marketing Through Wholesale Channels.** (A. A. Brown, R. W. Brundage, and J. A. Ward.) This study was conducted on a regional basis in cooperation with PMA, BAE, and several of the other Northeastern States. A joint report is being prepared at Cornell.

Within Massachusetts the wholesale market appears to handle, as closely as can be estimated at the moment, one third of the eggs annually produced on Massachusetts poultry farms. The balance of the production going into market-egg channels is sold directly by poultrymen to jobbers, institutions, stores, retail route operators, and consumers.

The wholesale market is further differentiated seasonally. Its location and structure vary according to changes in the size of the "nearby" supply. During the months of heavy production the wholesale market for "nearbys" actually exists. In the short season, wholesaling, as commonly considered, is very limited. Throughout the entire year, however, the volume of nearby eggs being sold outside the market is substantial and poses a problem relative to the adequacy of current pricing methods.

Some attention was given to pricing methods and price reporting in this study. The results served as a basis for developing a study on "Egg Pricing in the Boston Market."

**Marketing of Massachusetts Potatoes.** (R. A. Fitzpatrick, A. A. Brown, and J. A. Ward.) The survey of permanent potato storage facilities in producing areas in Massachusetts, which was made in 1948, has revealed an increase in the use of storage. The survey showed that there were 62 operators, having 84 storages with a total capacity of over 900,000 bushels, equivalent to 30 percent of the commercial crop. The wider use of winter storage dates from the mid-war years, and has resulted largely from two influences; viz., the effects of interregional competition, and the price support program.

Before the war, Massachusetts produced a crop of early potatoes which amounted to about 45 percent of the State's annual production. This crop was marketed after the heavy shipments from the Intermediate states, and before the marketings from the Surplus Late states. Continuing pressure from outside areas producing a similar crop had narrowed the local marketing advantage, and a trend toward greater production of late varieties was in progress. The price support program, effective with the 1943 crop, accelerated the shift toward late potato production, and to the accompanying development of storage operations. During the latter years of the war, the early varieties had declined to about 30 percent of the total State production.

Associated with both storage and price support has been an increasing emphasis on cultural practices aimed at increased yield per acre. Thus, while the total acreage in the State showed a downward trend after 1943, yield per acre was rising. The wide use of machinery and commercial fertilizer, and generally favorable weather effected, in 1948, the highest average yield per acre in Massachusetts history. The result was that although the total acreage in 1948 was 34 percent below that of 1943, total production in 1948 was only 5.4 percent smaller than that of 1943.

The trend toward production of more late potatoes may be of long-run nature. If this assumption is correct, the use of winter storage must become a permanent

feature of local marketing practices. It is evident from the storage survey that some producers and dealers have committed themselves to the regular use of storage facilities. This development accentuates some existing marketing problems and creates others.

The study has thus far determined the characteristics of the supply of local potatoes, and has described and evaluated the development of winter storage. The work in progress involves a detailed analysis of distribution of the local crop, and a phase of this work is concerned with a survey of potato-buying practices of retail-store operators.

**Production Adjustments on Representative Massachusetts Farms.** (B. D. Crossmon.) Farm management case studies are under way on 32 Massachusetts farms. Information has been secured showing the organization and practices on all farms, while so far detailed budgets have been prepared for eight farms. These indicate the enterprise structure, physical inputs and outputs, and receipts and expenses for a selected base period. The profitability of proposed adjustments on these eight farms has been pointed out by using the budgets as a base and making appropriate modifications to prices, to combination of enterprises, or to rates of using input factors.

Farms so far selected for study have been in the Connecticut Valley area of Hampden and Hampshire Counties, in Worcester County, in Plymouth County, and in Barnstable County. To date, the two types of farming receiving the most study have been dairy and cranberries. Part of the dairy farms in the Connecticut Valley area were chosen in cooperation with the BAE, USDA, as a part of a regional study on possible cost reduction. The cranberry growers are concerned with the costs of typical bog operations.

Follow-up visits with the county agent to five dairy farms studied in Hampden County showed farmer movement toward the more profitable alternatives budgeted. The adjustments tended toward the increased herd production of several thousand pounds per farm shown as possible in the proposed budgets. Improved roughage, use of artificial breeding and barn re-arrangement to save labor were other current adjustments. Adjustments on these farms have been considered in college teaching.

Five case write-ups were made during the year and copies supplied cooperating farmers, county agents, and the State Extension office. These will later be combined with others into an Experiment Station publication. These data served as the basis for two articles: (1) "A Farmer Looks Ahead," in *Farm Economic Facts*, March 1949; (2) "The Farmer Gets Pinched," in *Farm Economic Facts*, June 1949.

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## DEPARTMENT OF AGRICULTURAL ENGINEERING

### H. N. Stapleton in Charge

#### Forage Handling Investigations. (H. N. Stapleton and Earle F. Cox.)

*Barn Hay Drying.* The work on high volume fans to supply unheated air for mow drying has been continued. As previously reported, the investigation of fans suitable for use with electric motors of  $7\frac{1}{2}$  HP or less has been the primary consideration. On the four installations in the mows at the University Farm it has been impossible this season to impose water loadings approaching the calculated evaporative capacity of the fans. On all of the installations, hay has cured satisfactorily. The driest June of record at this Station produced hay which went on the driers at 28-38 percent moisture, with 2 to 4 hours in the swath and windrow.

One high, narrow mow 12 feet by 24 feet received 17 tons of hay which produced an initial depth of 25 feet. The static pressure on the side main serving the slatted floor at no time exceeded 5/8 inch water column. The air supply was provided by a 3 HP 42-inch 2-blade propeller fan which a cooperating manufacturer has developed, on the basis of our previous reports and current recommendations.

Test work with the blast-tunnel has indicated that if maximum delivery is to be obtained from manufacturer's stock fans, the fan tip must be adjusted for minimum practicable clearance from the mounting ring. The desirability of using a variable pitch pulley for the motor, to obtain final adjustment of the drive was shown by the data which developed that percentage loss in air delivery from underspeed is greater than the percentage of underspeed. The test work on 3-phase motors operating on single-phase input for this application will be made the subject of a later report.

**Air Conditioning of Animal Shelters and Crop Storages.** (H. N. Stapleton and Earle F. Cox.)

*Improvement of Poultry House Ventilation.* The study of the application of fan ventilation to poultry houses was begun in an attempt to find a more satisfactory means of litter-moisture control, and to evaluate other incidental benefits.

Tests the past season have shown that heat balance calculations developed according to standard ventilating practice provide a satisfactory basis for predicting the performance of the fan ventilating system. When climatic conditions and the insulation provided in the structure permit pen temperatures in excess of 40° F., the heat available from litter decomposition in deep litter and from solar radiation may be almost as great as the sensible heat available from the birds with present poultry management practice. The regulation of pen temperature with varying outdoor temperatures is most easily accomplished by thermostatic control of the amount of fan delivery.

Data from recording hygrothermographs showed that the most efficient use is made of available heat when the fan inlet is placed in the dropping pit, if this item of equipment is used. When one of several pens is fan-ventilated, moisture movement from adjacent pens is measurable, both in the air and litter condition of the pens and in the moisture load of the air moved by the exhausting fan.

Work with cooperating farmers indicated that litter replacement stored under cold conditions before introduction into the pen can bring excessive moisture with it. One farmer changing litter weekly was found to be introducing apparently dry but cold shavings at 38 percent moisture into his pens after removing wet litter which tested only 32 percent moisture.

**Warm Room Brooding.** (Earle F. Cox.) To reduce the room temperature which developed from the use of a wall-mounted pipe panel and to obtain a more accurate measurement of the heat input, the hovers were modified by the addition of electric resistance heating elements. Within the brooder area the inclined hover surface increased the degree of vertical temperature gradient. With the upper edge of the inclined hover attached to the wall, stratification within the hover area developed so that satisfactory floor temperatures could not be obtained. When fans were installed to reduce the stratification, some heat pockets still remained with excessive velocities developed at the floor.

A recording voltmeter indicated that a voltage of 106 was frequently encountered. Therefore, it was felt that a true measure of the merits of using electric resistance heating elements on inclined hovers could not be made until a higher and more uniform voltage was used. Corrective measures are in process.



## DEPARTMENT OF AGRONOMY

Dale H. Sieling in Charge

**An Improved Method for Determining the Phosphate-Fixing Capacity of Soils.** (Dale H. Sieling and Garland B. Bass.) Most methods for determining the phosphate-fixing capacity of soils are long and tedious; present many difficulties in manipulation; and require special reagents and a centrifuge to effect a complete removal of excess phosphate before the fixed phosphate can be replaced and determined.

It is rather well established that *active* iron and aluminum are largely responsible for the fixation of phosphates in acid soils. For this reason it was believed that these components of the soil might be extracted from the soil by a selective solvent and that, after separation from the soil, they could be determined quantitatively to give a value for phosphate-fixing capacity which would compare favorably with that obtained by the more tedious and time-consuming direct method. In a previous report it was shown that *active* iron and aluminum are easily complexed and rendered soluble by the citrate anion. This complexing was so effective that these metal ions could not be precipitated by either phosphate or hydroxyl ions as would normally take place in the absence of the complexing anion. Citric acid was therefore chosen as the selective solvent for extracting the *active* iron and aluminum.

Samples of several soils, with a wide range of phosphate-fixing capacities as determined by the direct method, were extracted with citric acid under several sets of experimental conditions with regard to temperature, time, and concentration of the reagent. For the several soils tested in this preliminary experiment to establish the ideal conditions for the determination, values obtained for phosphate-fixing capacity of soils closely approximated those determined by the direct method, when the following procedure was used. Twenty grams of soil were extracted with 75 ml of 0.5 molar citric acid by heating for one hour in a boiling water bath, filtering immediately, and washing the residual soil 6 to 7 times with hot water. The filtrate and washings were collected into a volumetric flask and appropriate aliquots were removed for the determination of the extracted iron and aluminum after the organic matter was destroyed and the silica dehydrated by digestion with a nitric acid-perchloric acid mixture.

The combined iron and aluminum content of silica- and organic-free extracts was determined quantitatively by a special method developed in this study. This method is based on the fact that iron and aluminum may be precipitated quantitatively with phosphate at pH 3.4 in the absence of complexing anions and without interference from other cations which would be present in soil extracts. The advantage of this method is that equivalent quantities of iron and aluminum react with like quantities of phosphate, thus allowing simultaneous determination of the two elements as a single fixing agent for phosphate without regard to the actual content of each. The total phosphate content of the precipitate formed at pH 3.4 and thoroughly washed with 1 percent NaCl solution to remove adsorbed phosphate is determined colorimetrically after the precipitate is dissolved in dilute perchloric acid.

The principal advantages of this extraction method over the direct method for determining the phosphate fixation of soils are (1) a larger, more representative sample of soil is used; (2) less than one-half as much time is required for each determination; (3) the difficulties encountered in washing the unreacted phosphate from the soil in the direct method are eliminated; (4) the active constituents responsible for the fixing process are converted to a pure inorganic chemical system after removal of interfering substances—in this form they can be deter-

mined accurately and rapidly; and (5) no special laboratory equipment is needed for the determination.

The phosphate-fixing capacities of 40 soils from Maine, Vermont, New Jersey, North Carolina, Alabama, and Massachusetts were determined by this proposed method and by the direct method. The values obtained in each soil by the two methods were practically the same, even though the range of the fixing capacities varied from 5-80 millimols per 100 grams for the different soils.

**Release of Fixed Phosphates by Organic Anions as Influenced by pH.** (Dale H. Sieling and Paul H. Struthers.) It has previously been reported that certain organic anions were effective in replacing phosphate which had been chemically combined with iron and aluminum as basic phosphates. All of these replacement reactions were carried out at the pH of maximum precipitation of the basic phosphates—pH 3.0 for iron and pH 4.0 for aluminum. Since these pH values are below those normally found in agricultural soils it seemed advisable to determine how effectively certain of these anions would replace the chemically combined phosphate at pH values throughout the range from pH 3.0 to 8.0 for iron and pH 4.0 to 9.0 for aluminum. These were the pH ranges for iron and aluminum which were effective in fixing a considerable portion of soluble phosphate and covered the entire range of pH's of agricultural soils.

The anions of citric, oxalic, malonic, tartaric, lactic, succinic, malic, aspartic, and alpha amino propionic acids were used as replacing anions. One millimol each of iron or aluminum phosphate and of the replacing anion were mixed in a definite volume and the pH of the mixture was adjusted to the desired value with sodium hydroxide. After boiling for one-half hour the amount of phosphate chemically combined with the iron was determined. By this procedure a measure of the relative affinity of the phosphate and the organic anion for the iron or aluminum at different pH values was obtained and it gave a value for the replacing ability of the anion.

It was found that the two amino acids, aspartic and alpha amino propionic acid, were not effective in replacing phosphate at any pH value. Citric acid was most effective for iron at pH 4.8 to 5.0 and for aluminum at pH 5 to 6. Citrate was the most effective anion tested and was more active in replacing phosphate from basic aluminum phosphate than from basic iron phosphate. Malic acid was most effective at pH values 4 to 5 for both iron and aluminum; while oxalic acid showed greatest replacing power at pH 3.0 for iron and at pH 4.0 for aluminum. Malonic acid was most active at pH 4.0 for the aluminum system but showed equivalent replacing ability for phosphate from the iron salt throughout the entire pH range from 3 to 8. Lactic acid was effective to a greater degree at pH's above 6 than below for both iron and aluminum. Tartaric acid showed the greatest effect at pH 4.0 for basic aluminum phosphate and at pH 3.0 for basic iron phosphate.

In addition to this systematic investigation of the various anions, it has also been observed that galacturonic acid is a very effective phosphate replacer. Pectic acid obtained by dilute alkali hydrolysis of pectin was also found to be very active in phosphate replacement and in complexing iron. Since pectin is found in all plant residues it seems reasonable to assume that it might have a very important role in preventing phosphate fixation in soils and in mobilizing iron and aluminum. The fact that as much as one-third of the organic matter of some soils is in the form of uronides may account for the fact that phosphate fixation is less severe in soils of high organic content than in others. It is conceivable that the uronides have been the effective mobilizing agents in the transfer of iron and aluminum to the B<sub>1</sub> horizon of podzols since this is the zone of accumulation of uronides as well as of iron and aluminum.

**The Availability to Plants of Applied Phosphorus as Influenced by the Presence of Organic Materials and Fluoride.** (Dale H. Sieling and Glenn C. Russell.) Plants were grown in pot culture on a soil known to have a high phosphorus-fixing capacity and a low phosphorus content. Phosphorus was applied to the pots at rates equivalent to 80, 120, and 160 pounds of  $P_2O_5$  per acre as control treatments. Other pots at the 80-pound level were treated with spent hops, citrate, or fluoride. Results showed that the applied phosphorus resulted in greater phosphorus uptake although growth was not improved over controls. In pot culture with no drainage the use of 200 p.p.m. of fluoride proved toxic.

Plants were grown in sand culture with basic iron and aluminum phosphates as the source of phosphorus. Phosphorus in this form was applied in the same quantity as the phosphorus applied as  $KH_2PO_4$  in Knop's nutrient solution in the control cultures. Cultures were set up with ten and twenty times the basic level of phosphorus of the controls. Cultures at the lowest level were also treated with citrate and fluoride. Growth and phosphorus uptake at the low level of phosphorus were poor, but were improved by the use of citrate and fluoride. Fluoride at the rate of 10 p.p.m. did not prove toxic to germination or growth. Cultures containing ten times the initial level of phosphorus gave better growth but not equivalent to that of the control. Phosphorus at twenty times the initial level resulted in growth and phosphorus uptake comparable to that of the control.

Actively decomposing organic matter results in more effective use of applied phosphorus in soils by the production of organic acids, some of which form stable complexes with iron and aluminum, thus releasing fixed phosphate or preventing its fixation. The action of one of these organic acids is illustrated by the effect of citrate on phosphorus uptake even though the citrate was applied in small quantities. The use of fluoride to replace fixed phosphate in soils would not be practical, because fluoride in sufficient quantities to appreciably increase the effectiveness of applied phosphorus would be toxic. Basic iron and aluminum phosphates, when present in very large quantities, release enough phosphorus by hydrolysis to produce normal growth.

**Value of Spent Hops from Breweries as a Source of Organic Matter for Use in the Growing of Turf.** (Dale H. Sieling, L. S. Dickinson, and Moyle E. Harward. Cooperating Agent: P. Ballantine and Sons.) Results from studies made to date give definite indication that spent hops have value as a pre-seeding amendment to sandy loam, silt loam, and clay loam soil. Comparisons were made with soils treated with peat moss and cultivated peat and checks. Before an application of fertilizer was made, the stimulation of growth was very marked on the hops plots. After fertilizer applications, the influence of the fertilizers remained more than three weeks longer on the hops plots than on all other plots. Field plots treated in December remained smooth and without cracks throughout the following spring, while other areas were heavily cracked. Very favorable results have also been obtained with hops as a greenhouse mulch for roses and gardenias. Further studies are warranted, particularly as to the value of hops as a top-dressing on turf to furnish organic nitrogen, also as a conditioner and source of organic nitrogen in commercial fertilizers.

**The Absorption of Chemical Elements by Plants.** (W. S. Eisenmenger and Karol J. Kucinski.) There is some belief that the chemical composition of rocks from which soils are weathered determines the relative amounts of plant nutrients that are taken up by plants grown upon these soils. Seven different species of plants which had grown on four different soil series were collected for chemical analysis. The soils, of the Dover, Gloucester, Holyoke, and Cheshire series, were



chosen because they had weathered from rocks having a wide difference in chemical composition—limestone, granite, basalt, and sandstone, respectively. The areas from which the plants were picked had never been fertilized or cultivated. Based on the calcium and magnesium content of these plants, the soil series ranked in descending order as follows: Holyoke, Dover, Gloucester, Cheshire. Based on phosphorus content, the rank in descending order was Dover, Gloucester, Holyoke, Cheshire; but the differences in phosphorus content of the plants on the different soils was not great.

**Magnesium Requirements of Certain Plants.** (W. S. Eisenmenger and Karol J. Kucinski.) Because of the expanding building program on the University Campus, the original magnesium deficiency plots have had to be abandoned. However, the topsoil from the deficient plots to plow depth was moved to another area after the topsoil at the new location had been scraped off. Plants grown on these plots showed definite symptoms of magnesium deficiency, which were most severe on the unlimed portion of the area.

Studies of crop yields and chemical analysis of soils from various parts of western Massachusetts indicate that the soils which are weathered from triassic sandstone furnish less magnesium to plants than soils weathered from granite, limestone, or basalt. It may be generally concluded that soils with a high pH (6 to 6.8) are quite fertile and plants grown on them seldom show symptoms of magnesium deficiency.

**Tobacco Quantity and Quality Following Early Fall Application of Nitrogen Fertilizer.** (W. S. Eisenmenger and K. J. Kucinski.) Tobacco was grown on an area where corn had been grown the previous year. On one-half of the area corn was harvested before plowing; on the other half, the corn plant was plowed under. The purpose was to study the effect on the tobacco of the residual fiber from the corn crop.

Nitrate of soda was applied in the early fall, to supply 0, 50, 100, or 200 pounds of nitrogen per acre; and tobacco was planted on the area the following spring. Where 50 pounds of nitrogen was added, there was no increase of yield or crop index<sup>1</sup> over the control. Where the corn was plowed under and 100 pounds of nitrogen added, the yield and crop index were about the same as for the control; but where the corn was harvested and 100 pounds of nitrogen added, the yield and crop index were markedly increased. Where 200 pounds of nitrogen was added, the crop index and yield were increased by about 10 percent.

**Trials with Cutting, Management, and Nitrogen Fertilization of Timothy.** (Wm. G. Colby.) Timothy is by far the most important hay grass grown in Massachusetts. Within recent years, increasingly large amounts of complete commercial fertilizers have been applied to haylands to increase the yield of hay and also to improve the feeding quality. In years of abnormally high rainfall in the spring, the growth of grass may be so rank and lush by haying time that excessive lodging frequently occurs. Losses from lodging and increased difficulty in curing the hay frequently nullify the beneficial effects of the fertilizer. In an attempt to develop a practical system of management which would eliminate or at least substantially reduce lodging losses, a series of plots was laid out on a year-old timothy stand during the summer of 1948. All plots were limed and liberally fertilized with superphosphate and potash. The two variables studied were the time and amount of nitrogen applied and the time of cutting. The first year's results indicate that lodging can be substantially reduced (1) by applying nitrogen in the late fall or early spring and cutting the hay early—about the first or

<sup>1</sup> Crop Index is the term used for a single figure which combines grading quality and yield.

second week of June; and (2) by applying nitrogen after the first crop of hay, cut at full-bloom stage, has been removed.

Sixty pounds of elemental nitrogen applied July 1, 1948, produced a second or rowen crop of approximately two tons to the acre compared with slightly over three-fourths of a ton from the check. These results were obtained even though the rainfall for the months of July, August, and September was much below normal. Sixty pounds of nitrogen applied in the spring of 1949 produced at the rate of 3600 pounds per acre on the early-cut series of plots compared with 2025 pounds on the checks.

**Breeding Work With Orchard Grass.** (William G. Colby.) Further plant selections were made from plantings of the Finnish late hay strain of orchard grass. Several of these plants approach the writer's conception of the ideal orchard grass type for use in the Northeast. They are late maturing. Maturity dates for individual plants range from one to two weeks later than the maturity dates for commercial strains. These plants have stiff leafy stalks of medium height with many of the leaves arising high on the stalk. No serious injury has as yet been observed from leaf spot diseases. Progressive tests are being conducted to determine breeding behavior, winter hardiness, and other characteristics. A space-planted nursery of 7500 plants was started last summer with the hope that more plants with as good or even better growth characteristics can be isolated.

**Strain Trials with Smooth Brome Grass.** (William G. Colby.) Some of the more common strains of brome grass including Elsberry, Achenback, Fisher, Lincoln, Martin, and Canadian Commercial were grown in association with Ladino clover. Seeding was done in August, 1947. The spring of 1948 was cool and wet with the result that all six strains made rank growth and then lodged badly. Much of the Ladino clover was killed by smothering. There is need for a stiff-stalked strain of smooth brome grass of medium height which is more lodge resistant than any strains now available.

**Red Clover Variety Trials.** (William G. Colby.) These trials, conducted for several years in cooperation with the U.S.D.A. Bureau of Plant Industry, have demonstrated the superiority of Kentucky selection (recently named Kenland) over all other strains of red clover tested. To gain further information on the adaptability of Kenland red clover, one hundred pounds of seed were distributed to cooperating farmers in different sections of the State.

**The Improvement of Havana Seed Tobacco.** (C. V. Kightlinger.) This project is concerned with the improvement of Havana Seed tobacco in disease resistance, type of plant, type and quality of leaf, and productiveness; also improvement in cultural and management practices to enable farmers to raise the improved strains with greatest benefit both to themselves and to cigar manufacturers.

Work is under way to breed strains that are highly resistant to mosaic and wildfire, as well as to black rootrot. It is the aim to incorporate high resistance to all three diseases into the same strain. It is, however, with the black-rootrot problem that most progress has been made to the present time.

A few strains of Havana Seed tobacco have been developed that yield well and produce tobacco of excellent type and quality, both under favorable growing conditions and under black rootrot promoting conditions, as well. Havana 211, Havana K1, Havana K2, and Havana K2-24 are the best of the new strains produced so far; and of these, Havana K1 and Havana K2-24 seem to have gained

the general preference of both the farmers and the tobacco trader. Other strains are being developed which at the present stage promise to be superior to those already produced.

The first of the improved strains of Havana Seed tobacco was introduced for farmers' use in 1933. Since that time the use of the improved strains has increased steadily. Conservative estimates indicate that at least 75 to 80 percent of the total acreage of Havana Seed tobacco in the Connecticut Valley at the present time is planted to these strains. The average annual yield per acre of Havana Seed tobacco in Massachusetts was 240 pounds higher for the period 1933-1947 than for the twelve years preceding 1933—an increase attributable largely to the resistance of the new strains to black rootrot. It is thus evident that the use of these improved strains has been profitable to our tobacco growers.

**Effects of Fertilizing Tobacco Seedbeds in the Fall and in the Spring.** (C. V. Kightlinger.) It has been the purpose of this experiment to compare the effects of fall fertilizing and spring fertilizing with organic and inorganic fertilizers on the germination of seeds and the subsequent growth of plants in tobacco seedbeds sterilized with chloropicrin and in those not sterilized.

The experimental plots in the seedbed were 12 feet long by 6 feet wide. The fertilizers used were 6-3-6 tobacco fertilizer and 5-8-7 inorganic fertilizer, applied at the rate of 12 pounds per plot or slightly more than 166 pounds per 1000 square feet. This rate of application is heavy, but not more than many farmers use regularly.

*Fall-Fertilized Plots.*—Germination of seed and subsequent growth of plants were very good on the sterilized plots; in contrast, while germination was very good on the unsterilized plots, subsequent growth of plants was very slow. There was little difference between the effects of the two kinds of fertilizer. The difference between the growth of the plants on the sterilized and unsterilized plots, however, plainly showed the value of sterilizing tobacco seedbed soil.

*Spring-Fertilized Plots.*—Germination was very poor on all plots, regardless of the kind of fertilizer used and whether or not the soil had been sterilized. The few seedlings that lived grew very slowly at first, but later, apparently after the fertilizer had lost its harmful effects, they grew rapidly. For some reason not fully understood, germination was a little better on the unsterilized than on the sterilized plots. On the sterilized plots, the tobacco fertilizer gave slightly better germination than the inorganic. There was little difference in the subsequent growth of the few seedlings that survived on any of these plots. The germination of seed and the stand of plants were so much better in the fall-fertilized than in the spring-fertilized plots that the value of fertilizing tobacco seedbeds in the fall was clearly shown.

The general conclusion from this experiment is that it definitely pays to sterilize tobacco seedbeds and to fertilize them in the fall.

**Tests of Spray Materials for the Control of Late Blight of Potatoes.** (C. V. Kightlinger and H. M. Yegian.) The materials tested in comparison with Bordeaux mixture (5-2½-50) were Dithane 14, Dithane Z78, and neutral copper (yellow cuprocide), applied in spray form in accordance with the recommendations of the manufacturer. All the materials were applied at the rate of 150 to 175 gallons of spray per acre. The experimental plots were one-thirtieth acre in size. All plots, including the check plots to which no fungicide was applied, were replicated four times. The Green Mountain variety of potatoes was grown. They were sprayed weekly from mid-June until frost killed the vines, except in mid-



season when they were sprayed every five days for a short period. DDT and nicotine were used as needed to control insects.

All three of the materials tested gave acceptable control of blight and were more convenient to use than Bordeaux. Dithane Z78 was without question as effective as the Bordeaux mixture in its control of blight, and Dithane 14 and yellow cuprocide were little if any less effective. None of the three materials had any noticeable depressing effect on the growth and development of the potato vines, while the depressing effect of the Bordeaux mixture was very noticeable.

**Potato Variety Trials.** (Karol J. Kucinski and Ralph W. Donaldson.) Varieties of potatoes tested in 1948 with respect to their yielding qualities ranked as follows: Pontiac, 580 bushels; Green Mountain, 542; B61-3, 513; Sequoia, 489; B76-43, 476; Kennebec, 468; Houma, 457; Sebago, 441; Katahdin, 407; Cobbler, 341; Teton, 332; Chippewa, 326; White Rose, 315; Markota, 213; Mohawk, 202; Erie, 188; and Pawnee, 175.

**Soil Conservation Projects.** In Cooperation with the Research Division of the Soil Conservation Service, United States Department of Agriculture. (Karol J. Kucinski, Project Supervisor.)

*Effect of Loss of Topsoil on Crop Yields.*—In order to illustrate the value of topsoil and organic matter, a field experiment was initiated in 1942, in which the topsoil to plow depth was totally removed from a plot, while an adjacent plot was left undisturbed as a check. Portions of both plots have been fertilized annually, while the remaining portions have received no fertilizer. The crops grown have been spring wheat, white sweet clover, buckwheat (twice), winter rye, and oats. The decrease of crop yield due to topsoil removal ranged from 24 to 81 percent on the fertilized plot, and from 52 percent to complete crop failure on the unfertilized plot.

*Fertilization of Beach Grass.*—Beach grass plots at Sagamore were top-dressed with varying amounts of fertilizers of different ratios, to see whether it is possible to increase stands of beach grass for use in propagation work in the stabilization of sand dune areas. Application of a complete fertilizer (with one-half of the nitrogen from organics) at 500 to 1000 pounds per acre has given promising results. Inorganic nitrogen top-dressing alone has produced exceptionally good propagating stock of beach grass.

*Investigation with Various Winter Cover Crops for Onion and Potato Fields.*—An intensive program was initiated last fall by the various agricultural agencies in the Connecticut Valley to promote the use of winter cover crops. The results were most gratifying, with nearly all farmers in the Valley cooperating.

Various winter cover crops were seeded at weekly intervals during the fall to determine dates for seeding of the crops to produce a desirable mat to prevent wind and water erosion during the fall and winter months. Because of the exceptionally mild winter, oats and barley did not winterkill, and desirable cover was produced when they were seeded not later than the last week of October. Rye and winter wheat produced satisfactory stands when they were seeded before the second week of November.

*Farm Fish Ponds.*—In New England, farm fish ponds are a new venture, and very little is known about the yield and rates of growth of self-propagating fish in this area. Several ponds are being constructed at the Experiment Station for study of the various phases of the subject, and additional ponds with private ownership are being used to enlarge the scope of the study.

**Irrigation Studies and Management of Irrigated Soils.** (Karol J. Kucinski, Herbert N. Stapleton, and Dale H. Sieling.) Tobacco, truck, and dairy farmers in Massachusetts are showing considerable interest in portable irrigation systems. There is some indication that the increase in crop yield, the insurance against crop failure, and the improvement in quality of product will justify the cost of installation and maintenance.

Studies have been initiated to investigate all phases of supplemental irrigation as it applies to the various kinds of crops, fertilization, changes in soil structure, and effect on diseases and pest control, as well as to yields and quality of crops. The cost of installation and maintenance is being investigated in cooperation with the Department of Agricultural Engineering.

**Field Tests with Magnesium.** (Karol J. Kucinski.) For a good number of years we have been studying the importance of magnesium in plant nutrition, and considerable information has been gathered with respect to the requirements of various species of plants for this element. The academic aspect of the functions of magnesium as a plant food, although not always satisfactorily answered, have been thoroughly investigated and the results generally accepted. Corrective measures for areas showing extreme symptoms of magnesium deficiencies have been accepted by the farmer. However, it has been felt for some time that, in farming areas where plants do not show extreme symptoms of magnesium deficiency, the soil may yet be lacking in magnesium for optimum plant growth and maximum crop yields. Accordingly, a series of field trials was undertaken during 1948 in cooperation with several farmers, using various field crops grown on different soils.

All plots received a liberal application of a complete fertilizer. Certain plots received in addition a magnesium supplement: either 200 pounds per acre of Epsom salt or Sul-Po-Mag, or 2 percent of MgO included in the fertilizer as a soluble salt. The crops were potatoes, field corn, ensilage corn, carrots, and pasture. All crops showed increased yields on the magnesium-treated plots. Field corn showed the least increase, 3 to 10 percent; ensilage corn, the highest, 56 to 68 percent. Potato vines remained alive and green longer on the plots receiving magnesium, and increase in yields was sufficiently pronounced to be readily noticeable as the potatoes were being harvested.

The results of these trials on soils with a seemingly adequate supply of magnesium point strongly to the false economy of not including 30 to 40 pounds of magnesium oxide in soluble form per ton of commercial fertilizer which is to be used for growing vegetable or field crops on alluvial or glacial outwash soils.

**The Control of Onion Diseases by Fungicidal Chemicals.** (Hrant M. Yegian.) Bacterial soft-rot and fusarium bulb-rot are the most destructive diseases of set onions in storage. For many years Connecticut Valley onion growers have sustained heavy losses from these two diseases. The organisms causing these diseases are commonly found in cultivated soils, especially those on which onions have been grown continuously for many years. They are most troublesome if the weather is rainy during the latter part of the growing season, more particularly during the time of harvesting. Immature onions, big fleshy bulbs, or thick-necked bulbs are especially susceptible to infection.

During the past four years, various fungicidal chemicals, Fermate, Puratized N5E, Isothan Z-15, Wettable 604, Wettable Spergon, Dithane D14 and Dithane Z78 were tested for the control of storage rot. The chemical compounds were applied in water solution as sprays three times at weekly intervals before the crop was harvested. They were also used as dipping solutions soon after the bulbs were topped. In either case there was no evidence that any of the fungicides was effective in controlling storage rot.

In most instances infection of the bulbs takes place through the wounds at the neck of the topped onions or through the damaged leaves and roots. The glabrous surface of the onion leaf does not retain enough of the fungicidal chemical for effective protection nor are the causal organisms in the soil killed by the chemicals. This may account for the failure of the treatments to control storage rot of onions.

**The Inheritance of Certain Characters in the Onion.** (Hrant M. Yegian.) During the 1948 season, crosses were made between new male-sterile lines furnished by U.S.D.A. and selected strains of our Ebenezer lines. Production of breeding stock and maintenance of pure lines were continued.

F<sub>1</sub> hybrid sets from the previous crosses were tested. One of the combinations, (5114 x 8512) x Massachusetts line 87 was very promising. It produced at the rate of 730 fifty-pound bags of No. 1. onions per acre. The bulbs were firm, globe-shaped, and had bright yellow skin. On March 15, 1949, under ordinary storage conditions, it had a total of 17 percent sprouted bulbs and only 2 percent neck-rot. Bulbs from Massachusetts 87 were sent to Mr. Peter Oleson, Crookham Company, Caldwell, Idaho, who was here to see the hybrid onion test and was interested in the performance of this line. They propose to use it in their hybrid onion seed production program.

**The Evaluation and Use of Flint Lines in Flint-Dent Corn Hybrids.** (Hrant M. Yegian.) Two new experimental hybrids, (CC4 x CC8) x (A96 x Z83) and (CC4 x CC8) x (NY3 x Q83), were introduced this year by this Station. These are early-maturing field corn and are considered to be an improvement over Mass. 62 which has been favorably received by farmers in Massachusetts and a few of the other Northeastern States.

Last year 45 all-combination single crosses involving 10 early-maturing inbred lines were produced with the objective of finding an early-maturing flint-dent hybrid. One of the important characteristics of flint lines in flint-dent crosses is the ability to hasten maturity from 5 to 10 days—a very desirable factor in areas where the growing season is cool and short.

Results of tests of 23 commercial hybrids and 7 experimental hybrids were reported to the cooperating seed dealers.

**Black Substances as Soil Amendments.** (John W. Everson and Roy Sigafus.) Where black non-nutrient substances such as charcoal, lampblack, or soot have been added to soil, crops have shown favorable responses. A study was made of water evaporation and soil temperature to determine whether the addition of non-nutrient black caused enough physical change in the soil to account in part for crop response.

Small surface applications of black, 400 pounds per acre, were effective. Evaporation increased with large additions; but when the amount used produced a mulch, evaporation was lowered. When mixed in the upper two inches of the soil, at least ten times as much black was required to produce the amount of evaporation produced by a surface application. Surface application is not practical because of blowing or washing away.

Through the growing season the maximum temperature was raised approximately two degrees and the minimum lowered half a degree. This widens the thermoperiodic effect and so has the same effect as advancing the season in the spring.

The use of carbon black as a soil amendment, however, is not recommended because of its cost and the fact that it is difficult and disagreeable to handle and tends to blow away when applied to the surface of the soil.



## DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

**A Study of the Mineral Elements of Cows' Milk.** (J. G. Archibald.) The work with nickel has been completed. Nickelous chloride (500 mg. daily) was fed as a supplement to the rations of six cows for a period of two months, by the double reversal method. Analyses of numerous samples of the milk showed varying amounts of nickel. However, when the milk was kept from contact with metal by milking directly into glass jars, nickel was not present. It was therefore concluded that nickel is not a constituent of natural milk and that the varying amounts found in the course of the investigation came from the milking machine.

A manuscript entitled "Nickel in Cows' Milk" has been accepted for publication in the Journal of Dairy Science.

**A Study of Quality in Roughage: Composition, Palatability, and Nutritive Value of Hays as Affected by Curing, Harvesting, and Storing Procedures.** (J. G. Archibald, M. L. Blaisdell, and H. N. Stapleton.) The work has consisted of two phases: (a) A biochemical study of the changes which take place in hay during the curing process and in storage, and of how these changes are affected by different methods of curing; and (b) feeding trials with milking cows of some of the lots of hay studied under (a). Tentative conclusions are:

1. Of the chemical constituents studied, carotene and sugar were subject to the most loss in the hay curing process. Carotene losses were extensive both in the field and after storage, beginning almost as soon as the hay was cut and continuing for weeks or even months in storage. Sugar losses were relatively unimportant in the field but were frequently extensive in storage, especially in hay that had been stored too damp.

2. Losses in protein, crude fat, and ash were relatively unimportant unless the hay had been exposed to excessive and/or repeated rainfall; after storage these constituents were affected little if any.

3. Carotene and sugar losses were appreciably less in barn-dried hay than in field-cured hay, provided the blower installation was adequate.

4. Feeding trials with eight cows, extending over a period of four months, showed no differences in milk yield as a result of feeding hay averaging 6.1 percent sugar in contrast with hay averaging 3.9 percent of sugar. All of the "high-sugar" hay had been barn-dried; most of the "low-sugar" hay had been field-cured.

5. Although it is admitted that the differences in these lots of hay, from the standpoint of appearance, composition, and palatability, were much less than the differences often encountered in practice and under our own observation; nevertheless, it is felt that the practice of barn-drying hay has much more to recommend it from the standpoint of speeding up hay making and saving hay from spoilage by weathering, than it has from the standpoint of improved nutritive value of the hay.

## DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

**Bacteriological Study of Sewage Sludge.** (James E. Fuller.) In a previous report on this project (Mass. Agr. Expt. Sta. Bul. 449, p. 18, 1948) it was noted that *Escherichia coli* survived longer in drying sludge stored at 37° C. than at room temperature of about 22° C. Subsequent study has indicated that 30° to 32° C. is a more favorable temperature than 37° for survival of *E. coli* in drying

sludge. This is near the temperature maintained in digestion tanks of sewage disposal plants.

The previous report indicated that the disappearance of *E. coli* from the drying sludge appeared to be the result of a combination of several factors; viz., lack of a readily available source of nutrient materials, unsuitable temperature, and inability to compete with other types of bacteria better suited to the environmental conditions. Subsequent study has indicated that the drying sludge contains ample nutrient materials but they are not in a chemical form simple enough to be available to *E. coli*. Other bacteria in the drying sludge can and do digest these nutrients to simpler states, but the process is slow and the products of the digestion are quickly utilized by the hardier types of bacteria present in the sludge and little is left for the less hardy *E. coli*.

Since the results of the experiments indicate that *E. coli* will disappear in a few weeks from sludge drying on a filter bed, it is highly probable that any pathogenic intestinal bacteria present would disappear even more quickly because they are less hardy than *E. coli* outside of the body or fresh feces. Bacteria that normally are found in the bodies of human beings and other warm-blooded animals are accustomed to body temperature and readily available food materials. These conditions do not obtain in drying sludge where the basic biological principle of survival of the types best suited to the environment is operative. Thus, it is reasonable to assume that well-digested sewage sludge which has been air-dried on a sand filter bed should be safe for use as a fertilizer even on garden soil, particularly if it is plowed into the soil before the crops are planted.

Sludge has much humus value, particularly when it is mixed with sandy soil. There is some nitrogen which soil bacteria will make available for crop use, and there are also some mineral salts. Since animal manures are comparatively scarce in many places, it would seem desirable to utilize this material if it can be proved hygienically safe. This study is a contribution in that direction.

**Survival of *Escherichia coli* from Sewage in Soil of Septic Tank Disposal Fields.** (James E. Fuller.) It has been reported previously (Mass. Agr. Expt. Sta. Bul. 446, 1948) that few *E. coli* isolations could be made from the soil of a septic-tank disposal field, even though the septic-tank effluent discharged into the soil contained ample quantities of the organism. The coliform types recovered from the soil were mostly those common in the soil of the field that received no sewage effluent. The recent work on this project has been a study of these coliform types isolated from the soil. A great deal of variability was encountered in their cultural behavior. Many which produced gas in lactose broth (the primary test employed for detection of coliform bacteria in water) when first isolated from soil promptly lost that capacity after their isolation. This capacity could be restored in some of these cultures but not in many of them. Other cultural reactions commonly employed to differentiate coliform types from one another proved to be unstable and variable. These results raise two questions:

1. Does *E. coli* in an unfavorable environment tend to change by mutation into coliform types that are not typical of the sewage type? This has been claimed by some investigators, and soil is definitely a less favorable environment for *E. coli* than are feces and sewage because soil contains less moisture and readily available nutrients, the soil temperature is more variable, and there is great competition for nutrients from bacteria that are native to the soil and that consequently are more at home in it.

2. Granted the disappearance of typical sewage-type *E. coli* from soil, how valid is the commonly accepted test for *E. coli* in evaluating the sanitary quality of raw waters? Should the laboratory insist on the presence of *E. coli* in such

tests and ignore the presence of other coliform types? Should search be made for other criteria of sewage pollution of water?

The work projected for the next year on this project will aim to find the answers to these questions, or some of the answers at least.

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## DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

**Diseases of Trees in Massachusetts.** (M. A. McKenzie, A. Vincent Osmun and D. H. Marsden.)

*The Dutch Elm Disease Problem.* New laboratories for studies of shade tree problems were completed in February, 1949, and are now operating with special attention to investigations of Dutch elm disease. From July 1, 1948, to June 24, 1949, the Dutch elm disease was found in 40 additional towns, making a cumulative total of 134 since the disease was first known here (1941, Alford, Berkshire County). Summarily, in laboratory studies by means of tissue plantings in artificial culture media, the disease fungus, *Ceratostomella ulmi* (Schwarz) Buisman, has been isolated from 3478 trees in 11 of the 12 counties on the mainland; Barnstable, Dukes, and Nantucket being reported disease-free at present. With notable isolated exceptions, the build-up of the disease is greatest in the Connecticut Valley and west of this area.

River valleys are natural sites for heavy reproduction and growth of elms, and generally they attain greatest size here. Accordingly, in such regions the number of weed elms may be excessive in contrast to the number of cared-for elms in areas where elms appear principally as shade and ornamental trees. Town tree maintenance programs vary widely throughout the State in the extent to which elms may be kept relatively free of dead material, and the degree to which the disease progresses locally may be closely allied to these community conditions. Additional considerations in disease spread involve failure to carry out control measures at the proper time. Essential sanitation work may be delayed for the sake of convenience or necessity if the potential cost of such tragic neglect is overlooked temporarily. A sound program of tree care, which is important for elms independent of the threat of Dutch elm disease, is imperative in disease control programs. Good intentions and procrastination are poor substitutes for constructive action, and with few exceptions local intensification of the disease may be ascribed to the absence of timely sanitation work. In this connection the greatest need of the program to control Dutch elm disease in Massachusetts is active participation by local tree departments.

The possibility that the use of spray materials to restrict vectors of the disease fungus may be a valuable adjunct to disease control by sanitation methods is under investigation in cooperative studies with the Department of Entomology. Considerable progress has been made experimentally, but many phases of this subject require additional study. Similarly, studies of disease resistance in elms require additional fundamental work.

As part of a program with the Massachusetts Department of Agriculture, elms found to be diseased in a scouting project are reported to municipal tree departments, property owners, or other agencies responsible for trees involved. In local disease control programs of 25 cities and towns where diseased trees or other elm material which might contribute to the spread of the disease have been cut and burned, the average increase in number of diseased trees locally has been reduced. This relative control varies from effective checking of disease spread in



adequately alerted towns to somewhat unsatisfactory disease checking in less fortunate places.

Eleven progress reports (mimeographed) and eight press releases were sent out during the year.

**Other Tree Problems.** Forty-six diseases of twenty-two species of trees including eight diseases of elms were identified from more than 800 specimens and inquiries received during the year. The *Cephalosporium* wilt of elm, which under certain conditions may resemble the wilting of foliage common with Dutch elm disease, was found widely throughout the State. Next in order of incidence was wilting of woody plants in association with the fungus, *Verticillium* sp.

Field observations of two other tree diseases previously reported briefly were continued this year and inquiries concerning both the dying of oaks and the occurrence of bronzed flags on maples have been numerous. A fungus tentatively identified as *Valsa* sp. was found most commonly in association with cankers on affected branches of maples, but no studies of its pathogenicity have been made. No further evidence of the cause for death of oaks has been found.

The death of several acres of hemlock was investigated, and the injury appeared to be associated with drought. Certain other species of plants died out completely on a rocky ledge in the area. No significant fungus or insect damage was observed.

A disease of mockorange (*Philadelphus* spp.) in which individual canes die, has occasioned numerous inquiries recently. Limited investigations have shown the trouble to be extremely common. In fact, few plants, if any, are totally free from it. The cause remains to be determined.

The severe midsummer drought of 1948, which extended into the autumn, caused damage commonly known as sun scorch on foliage widely throughout the State. Maples in particular were severely affected.

Winter injury was only slight or lacking this year. In fact, injury to flower buds of trees valued for their floral displays, such as dogwood (*Cornus* spp.), was so slight that they were at their best this spring, even in parts of the State where winter conditions often preclude profuse blossoms.

**Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment.** (W. L. Doran.) It was found that Japanese elm, like American elm and some Asiatic elms, can be propagated by softwood stem cuttings taken in June and treated with indolebutyric acid. This method was unsuccessful with the Buisman elm, a variety of *Ulmus carpinifolia* which is resistant to the Dutch elm disease; but that elm was successfully propagated by root cuttings taken in March and inserted, untreated, with the proximal ends projecting above the rooting medium. On the basis of this work, an article by W. L. Doran and M. A. McKenzie on "The Vegetative Propagation of a Few Species of Elms" was prepared and has been accepted for publication in the *Journal of Forestry*.

As treatments of the seeds of red pine in a forest nursery in May, Semesan gave better results, better stands than did Arasan, Zerlate, Spergon, or Phygon. With Phygon, the results were inferior to those with untreated seeds.

December cuttings of hemlock, *Tsuga canadensis*, made of wood of the current year rooted in larger percentages than did similar cuttings which were so made as to include, at the base, wood two or three years old. Best rooting, 80 percent, was of cuttings of one-year-old wood treated with indolebutyric acid 100 or 200 mg./l., 22 hours.

In work with root-inducing substances and fungicides, used together or separately, there were indications that Phygon (2, 3-dichloro 1, 4-naphthoquinone)

is useful and safe with cuttings of several species and that it hastens the resumption of growth of rooted cuttings of some.

Spergon, used as a powder dip on the base of cuttings, was apparently injurious to *Cotoneaster horizontalis*, *Daphne cneorum*, and hemlock. Phygon similarly used, without indolebutyric acid, improved the rooting of cuttings of *Cotoneaster*, *Daphne*, and *Picea glauca conica*. Rooting of November cuttings of *Cotoneaster* and hemlock was more improved by Phygon preceded by solution-immersion treatment with indolebutyric acid than by the latter used alone. And September cuttings of *Chamaecyparis obtusa nana* rooted in larger percentages when Phygon and naphthaleneacetic acid were used together than when the latter was used alone. September cuttings of *Picea glauca conica* rooted in twice as large percentages with Phygon alone as they did without treatment. December cuttings of hemlock rooted more rapidly after treatment with indolebutyric acid 100 mg./l., 19 hours and Phygon than after treatment with indolebutyric acid alone. Rooting of January cuttings of *Cotoneaster* was better with Phygon alone than with indolebutyric acid or indolebutyric acid and Phygon used together.

Since the coming into use of root-inducing substances, a principal problem is to induce rooted cuttings of some species to resume top growth. It was interesting to observe, therefore, that cuttings of *Daphne* treated with indolebutyric acid followed by (powder-dip) Phygon began to make new growth earlier than did untreated cuttings or those which had been treated with indolebutyric acid alone.

An article on "Low-growing Shrubs" by W. L. Doran was published in the *Flower Grower* 36:3:272-273. 1949.

**Diseases of Plants Caused by Soil-Infesting Organisms, with Particular Attention to Control Measures.** (W. L. Doran.) Fungicides were applied to soil in a 5-8-7 fertilizer (15 to 16 gm. per square foot) used as a carrier. Rates of application are in all cases expressed in grams of the fungicide or soil amendment per square foot of soil surface. Soil was treated immediately before seeding.

Onion smut caused by *Urocystis cepulae* Frost was prevented by 0.6 gm. of Arasan, Tuads, Phygon, or Fermate; but the best growth and least damping-off of onion seedlings was with Tuads or Arasan (tetra-methyl thiuram disulfide). There was 50 percent smut on onion seedlings in untreated soil, none with the above listed treatments, and growth of plants was much improved by them.

Arasan 1.0 gm. or Tuads 0.7 gm. gave slightly better control of damping-off of beet and tomato in limed soil than in unlimed soil. Stands of cabbage seedlings were improved by potassium chromate 0.44 gm.; those of lettuce by Phygon 0.65 or Tuads 0.65 gm. Damping-off of cabbage seedlings was better controlled by Phygon (2,3-dichloro 1,4-naphthoquinone) 0.7 gm. than by Arasan 0.7 gm.

Clubroot of cabbage caused by *Plasmodiophora brassicae* Wor. was not well controlled by 0.7 gm. of Arasan, Tuads, or Phygon in unlimed soil with a high moisture content. There was 100 percent clubroot in untreated soil, 38 percent with Tuads.

Clubroot of cabbage was not controlled by hydrated lime alone nor by mercurous chloride 0.2 gm. alone. But when they were used together, they gave good control; 13 percent clubroot in treated soil, 100 percent clubroot in untreated soil.

In another instance, the severity of clubroot was reduced by hydrated lime 25 gm., and the disease was entirely prevented by this application of hydrated lime used with mercurous chloride 0.35 or 0.4 gm. Mercuric chloride similarly used caused some injury to growth, and both salts were safer in limed than in unlimed soil.

Soil moisture is a factor, cabbage clubroot being easier to control with mercurous chloride and hydrated lime in a drier soil than in a less dry soil. In a limed soil, otherwise untreated, there was 78.1, 86.2, or 100 percent clubroot when this soil was watered to 50, 65, or 80 percent saturation, respectively. When mercurous chloride 0.3 gm. was applied to such limed soil, there was no clubroot in soil watered to 50 percent saturation, 7.4 percent in soil watered to 65 percent saturation, and 16 percent in soil watered to 80 percent saturation. Control was slightly less good when 0.2 or 0.25 gm. mercurous chloride was used, but in the least moist soil there was only 6.2 percent clubroot with 0.2 gm. mercurous chloride.

**Tobacco Frenching.** (L. H. Jones.) The work of the past year has been directed to ascertaining the causes of the variations in the strength of the so-called frenching factor in different soils, possible preventive and curative measures, diagnostic procedures to distinguish nitrogen-deficiency symptoms from frenching symptoms, the susceptibility of unrelated plants to the frenching factor, and the attempt to grow iron-deficient tobacco plants in sand culture. Two journal articles on frenching were published.

Experience has shown that one soil, in particular, was quite consistent in producing frenching in 5 to 12 days at a soil temperature of 95° F. However, this soil never produced frenching when air-dried, autoclaved one hour at 15 pounds steam pressure, or maintained at a soil temperature of 70°. Other soils, either compost or field, have not proved so efficient in producing frenching at the arbitrary soil temperature of 95° and produced none at all at the soil temperature of 70°. The frenching factor, suspected of being a micro-organism, appears to be more intense once it has been built up in the soil. Slow-reacting soils will react more quickly if inoculated with soil that has recently produced frenching.

It has previously been reported that the frenching symptoms result, apparently, from the inability of the plant to obtain a sufficient amount of iron, because of the competition of soil organisms for this element. An organic iron substance, ligno-sulfonate, was mixed with a soil subjected to a frenching temperature. Frenching was not prevented, but it was sufficiently delayed to warrant further tests with this material.

In cooperation with the Bureau of Plant Industry, a frenching soil was sent to Beltsville, Maryland, for testing. Samples of the soil taken before shipment and samples sent back to Amherst from Beltsville produced typical frenching symptoms, and correspondence from Beltsville indicated that frenching was obtained there from this particular soil.

As yet there has not been developed a quick and specific test that will distinguish the early symptoms of frenching from those of nitrogen deficiency. If a dark blue color is obtained by testing the cut midrib of a leaf suspected as having frenched with a sulfuric acid solution of diphenylamine, this is a positive test that eliminates nitrogen deficiency as a cause of the symptoms. The diphenylamine is a test for nitrates. A negative test would still leave uncertainty. While frenching symptoms have been obtained in less than 15 days, the shortest period to obtain similar nitrogen-deficiency symptoms was 26 days during the month of June. With shorter days and cooler temperatures, September, October, and November, the average number of days to obtain the interveinal pinhead chlorosis with 8 plants was 40 days, with a minimum of 30 days and a maximum of 58 days. Such nitrogen-deficiency symptoms were preceded by extreme chlorosis of lower leaves, the dying (firing) of the lowest leaves, and a marked retardation of growth. The similar pinhead chlorosis of frenching was not preceded by any observable symptom. The plants grew rapidly, as would be expected at



the high soil temperature of 95° F. At the time the symptoms appeared the lower leaves were usually a normal and healthy green. The first appearance of the pinhead chlorosis that was symptomatic of frenching was at the tip of a forming leaf. Succeeding leaves appeared with more accentuated symptoms, grading between and from the pinhead chlorosis symptom to the distorted sword shape, strap-leaf, or rosette of filiform leaves.

An attempt was made to separate frenching symptoms from nitrogen-deficiency symptoms on the basis of moisture content of the leaves. The moisture content of normal leaves was about 70 percent; of nitrogen-deficient leaves 87 percent; and of frenched leaves 93 percent. In a previous experiment the moisture content of frenched leaves was 84 percent. From these figures it does not seem possible that a moisture determination of fresh-picked leaves could serve as a diagnostic procedure to separate frenching and nitrogen deficiency symptoms.

Frenching has been reported as a disease of petunia. Tests with this plant failed to produce frenching symptoms at a high soil temperature. However, some of the plants were affected by a virus which produced a chlorosis and, to some extent, narrowed the leaves. This virus was present in plants in both the low and high soil temperatures. It is possible that the report of frenching on petunia failed to take into consideration the virus factor which was true of the frenching of tobacco many years ago.

On the other hand there was obtained evidence that ragweed (*Ambrosia artemisiifolia* L.) is subject to a physiological malady similar to the frenching of tobacco and induced by the same environment of a high soil temperature. The newer foliage became chlorotic and the segments of the leaves stringlike.

While high soil temperatures may be responsible for poor growth of carnation plants during the warmer months of the year, no evidence was obtainable that this plant was affected with any symptoms comparable to temperature-induced frenching of tobacco. Carnation plants at the high soil temperature of 95° F. were less sturdy, had less dense foliage, and were subject to an earlier death of the lower leaves than were the plants at the lower soil temperature of 70°. There was no evidence of chlorosis or other color differences which are characteristic of frenching or mineral deficiencies.

**Iron-Deficient Tobacco Plants in Sand Culture.** (L. H. Jones and E. H. Bitcover.) In an effort to compare iron-deficient tobacco plants with those showing frenching symptoms, tobacco plants were grown in sand cultures. The nutrient solution supplied to check cultures contained iron in the form of ferrous sulfate. Cultures were grown at the root temperatures of 70° and 95° F., as well as at the ordinary but varying greenhouse temperature. In no culture was there obtained what would be considered symptoms of iron deficiency. Although the sand was washed and pure chemicals employed to make up the nutrient solution, the tobacco plants apparently obtained all the iron necessary for normal development. The cultures at 95° utilized a great deal more water (25 liters) than did the cultures at 70° (10 liters) or the cultures at the greenhouse temperature (9 liters), although to all appearances the growth of the tobacco plants was nearly equal in all cases.

**Tomato Leaf Mold Caused by the Fungus *Cladosporium fulvum* Cke.** (E. F. Guba, Waltham.) Successive generations of hybrids of English tomatoes X Improved Bay State, and English tomatoes X Marglobe have been selected for desirable commercial type and resistance to tomato leaf mold. These hybrids derived their resistance to leaf mold from *Lycopersicum pimpinellifolium*, Plant Introduction No. 112,215 from Ecuador, S. A. The effort is intended to provide a wider assortment of leaf-mold resistant tomatoes.

A hybrid of *Lycopersicum esculentum* var. Prince Borghese X *L. peruvianum* (immune) outcrossed to Pan America by W. S. Porte (U. S. Department of Agriculture), designated 44B292, has been pure-lined for immunity to leaf mold and distributed to interested investigators. In anticipation of the appearance of a new race of the pathogen with a higher level of virulence than existing strains, Bay State and 44B292 have been crossed to provide a successor for such an eventuality.

**Search for Inherent Resistance to Tomato Late Blight Fungus.** (E. F. Guba, Waltham.) In the previous annual report (p. 25), it was stated that some types of tomatoes among a collection of approximately 200 primitive types indigenous to Central and South America were found to be immune to infection by the fungus *Phytophthora infestans* (Mont.) de Bary. These tomatoes were inoculated with the fungus from tomatoes from Florida, and from potatoes from Ontario, Canada, the latter considered to be a virulent tomato strain of the fungus.

These promising blight-resistant tomatoes were grown on a large scale in the winter of 1948-49 and subjected to similar conditions of inoculation but with inoculum from a local greenhouse planting of tomatoes. None of the tomatoes survived the inoculations. Another tomato, designated T-5, from Dr. W. T. Schroeder, New York State Agricultural Experiment Station, and asserted to be resistant to *Phytophthora infestans* (Mont.) de Bary is susceptible to the disease. This report concludes this project.

**Causes and Control of Decay of Squash in Storage.** (E. F. Guba, Waltham.) A rather complete collection of winter varieties of squash was grown in 1948. The squashes were stored in the greenhouse and the kinds of decay peculiar to each were recorded. Bacterial wilt rot and black rot caused by *Erwinia caratovora* and *Mycosphaerella citrullina* represented the most common types of decay.

**Resistance to *Fusarium dianthi* Prill et Del., the Cause of a Serious Carnation Wilt Disease.** (E. F. Guba, Waltham.) Some 75 seedlings, hybrids of disease-resistant parents, were shared with Patten and Company and Sim Carnation Company, Inc., for evaluation and further screening. Several of these seedlings are considered to have very promising commercial value and are being propagated on a large scale. The two concerns have furnished the originator with characterizations of all the seedlings submitted for appraisal. The new seedlings should get into the trade after two years.

More new seedlings will be available this year. The plan is to direct the carnation industry away from Virginia types, which are highly susceptible to disease and which have been a factor in significant losses from disease in recent years, and to provide new types resistant at least to *Fusarium dianthi* and *Alternaria dianthi*.

**Control of Diseases of Greenhouse Crops.** (E. F. Guba, Waltham.) In a study of the control of carnation stem rot and wilt diseases in the greenhouse by chemical soil treatments, the following fungicides have been considered: Copper 8-Quinolinolate; Fulex Soil Treatment B, having copper 8-quinolinolate as the active base; the thiocarbamate fungicides such as Parzate, Fermate, and Z-78; phenyl mercuri acetates such as Puratized Apple Spray and Tag 331; and other types of fungicides such as Malachite Green, Spergon, Phygon XL, and Thiosan. All of these chemicals were toxic to the spores of carnation pathogens, but only the mercury fungicides were bactericidal. When an excess of spore material and mycelium or slivers of rotted tissue infested with *Rhizoctonia*, *Fusaria*, and bacteria were immersed in an aqueous mixture of chemical, the action was fungistatic rather than fungitoxic. The concentration of the chemical was also a factor.

In the presence of soil, none of the chemicals was toxic at customary concentrations used in spraying plants. When large ratios of chemical powder to soil were mixed and moistened with water, disinfestation of nematodes and fungi was positive, but bacteria were not destroyed. In a descending series of ratios of chemical to infested soil, Fermate and Phygon outlasted the others; and in a ratio of about 12 pounds of chemical to a bed 100 by 4 feet by 6 inches (13 grams to 819 cubic inches), only Phygon was fungicidal but neither nematocidal nor bactericidal.

Fundamental studies suggest that fungicidal and disinfesting ratios of chemical and soil could be realized more readily by mixing chemical and soil before planting rather than by surface applications of the chemical in water after planting. By the latter method the toxic ratio of chemical and soil in the surface, theoretically, could be reached only after several applications at the rate of 1 pound to 100 gallons of water (1 quart per square foot of bed).

The studies show that 132 grams of chemical (Z-78, Fermate, Thiosan, Phygon XL, or Copper 8-Quinolinolate) to 819 cubic inches of soil (122 pounds to a bed 100 feet by 4 feet by 6 inches) produced a disease-free stand of seedlings of cucumber, tomato, vegetable peas, and sweet peas; otherwise the seedlings were usually badly stunted and abnormal. A fair degree of tolerance was exhibited by vegetable peas to Fermate, Thiosan, and Copper 8-Quinolinolate; by sweet peas to Z-78, Phygon XL, and Copper 8-Quinolinolate; and by cucumber to Phygon XL.

Up to now the studies have not shown that chemical soil treatments applied at periodic intervals since February when beds were planted to carnations are any more effective than water or no treatment. Some of these treatments have not controlled *Rhizoctonia* stem rot.

All of the fungicides considered were effective disinfestants when used to douse carnation cuttings, but only the mercury chemical (Puratized Agricultural Spray) was both fungicidal and bactericidal. Immersion of cuttings for 15 minutes in one fourth teaspoonful of this chemical to 1 gallon of water with wetting agent shows promise.

**Investigation of Fungicides Which Promise Value in Apple Disease Control.** (E. F. Guba, Waltham.) With the cooperation of Dr. Ernest E. Lockhart, Department of Food Technology, Massachusetts Institute of Technology, the residual mercury on apples from trees sprayed with Puratized Agricultural Spray (5 percent phenyl mercuri triethanol ammonium lactate) 1 pint to 100 gallons of water was determined. Apples from trees sprayed up to one month before harvest, or ten times, retained only about 5 parts of mercury per 100 million parts of fruit; apples from trees sprayed up to the middle of July, or eight times, showed mercury values essentially identical with those of apples from trees not sprayed with mercury. Whether the very small quantity of mercury retained by apples sprayed after the middle of July is of any consequence remains to be decided by Federal agencies, and no immediate decision from these sources is anticipated.

Foliage chlorosis from Phygon was prevented fairly well on Baldwin and Delicious by the addition of Epsom salt in a ratio of 1:1, but only partial correction was noted on McIntosh. The addition of Epsom salt caused a serious russetting of Delicious apples, but not of Baldwin. Insecticide alone (lead arsenate and DDT) seriously russeted Baldwin apples, but not Delicious.

Microtome sections of apple leaves from trees sprayed with phenyl mercuri monoethanol ammonium acetate (Puratized Apple Spray) and phenyl mercuri acetate (Tag 331) show the eradicator action of these solutions on manifest and



incubating foliage scab. In a comparison of six fungicides in a belated schedule of two and three applications beginning June 2 after scab was manifest, the phenyl mercuri acetates gave the best control of fruit scab and some disinfection of fruit infection.

**Miscellaneous Studies.** (E. F. Guba, Waltham.)

*Investigation of Chlorosis of Apples Caused by Phygon and Search for a Corrective.* (In cooperation with the United States Rubber Company.) Chlorosis was successfully produced on bean foliage in the greenhouse. Prevention or correction of chlorosis on beans was accomplished by the addition of Epsom salt, manganese sulfate, or magnesium phosphate in a ratio of  $\frac{3}{4}$  pound of chemical to 1 pound of Phygon. The differences in the results with these chemicals were narrow, but Epsom salt furnished excellent correction.

The use of Epsom salt for Phygon chlorosis on apple trees would seem appropriate, since it is widely used in the apple industry to prevent magnesium deficiency. In orchard tests chlorosis was prevented fairly well on Baldwin and Delicious by combining Phygon with Epsom salt in the ratio of 1:1. Partial correction was noted on McIntosh.

The manufacturer, in recognition of these and similar results, has combined Phygon with Epsom salt in the ratio of 1:1 in its product Phygon XL, and has recommended the addition of  $\frac{1}{2}$  pound of Epsom salt to each pound of Phygon XL in the spray tank. Phygon chlorosis was absent up to July 1, 1949, on Delicious; quite noticeable on Baldwin; and hardly noticeable on McIntosh foliage following four applications of Phygon XL and Epsom salt from April 22 to May 25. Delicious apples were russeted by this combination of chemicals. Foliage chlorosis was confined to the leaves present at the time of the orchard treatments.

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## DEPARTMENT OF CHEMISTRY

Walter S. Ritchie in Charge

**Factors Affecting the Vitamin Content of Milk and Milk Products.** (Arthur D. Holmes.)

*Composition of Percheron Mare's Colostrum.* (Arthur D. Holmes, Albert F. Spelman, and Robert F. Wetherbee.) The colostrum was obtained from four purebred Percheron mares maintained on the University farm for classroom instruction and draft purposes. The mares weighed from 1600 to 1900 pounds, were 4 to 11 years old, and were in the first to sixth lactation period. Thirty samples were collected for the first six days of lactation.

The average water content of the colostrum was very similar for the different mares. The protein value of the colostrum varied considerably, but was higher than that of milk produced by mares in later stages of lactation. The amount of reduced ascorbic acid in the colostrum was small compared with that found in mature milk. Initial samples of colostrum contained less phosphorus than later samples, but the colostrum contained more phosphorus than mature milk. Also the average amounts of potassium and magnesium were higher than in mature milk. The values obtained for colostrum during two lactation periods of the same mare were in close agreement.

*Loss of Reduced Ascorbic Acid from Lactose-Enriched Milk.* (Arthur D. Holmes.) In earlier studies the rate of loss of reduced ascorbic acid from mare's milk was found to be only a fraction of the rate of loss from cows' milk when both were stored in commercial glass milk bottles in the dark at 10° C. Since mares' milk contains much more lactose than cows' milk, it seemed desirable to

determine whether the addition of lactose to cows' milk would decrease the rate of loss of reduced ascorbic acid from cows' milk to that observed for mares' milk. Accordingly, on each of fifteen weeks between April and August, three samples of milk were prepared and assayed for reduced ascorbic acid daily for a five-day experimental period. To one sample, 15 grams per liter of analytical reagent grade *alpha*-lactose was added; and to a second sample, 30 grams per liter; while the third sample served as a control. There was no significant difference in the rate of loss of reduced ascorbic acid in the three series of 15 samples each, during storage in darkness for 96 hours at 10° C. From these results it was concluded that even though the lactose in mares' milk might not be in the same form as that added to the cows' milk, the high lactose content of mares' milk is not the principal factor in causing the greater stability of reduced ascorbic acid in mares' milk than in cows' milk.

**Changes in Vitamin Content Coincident with Different Stages and Rates of Maturity of Vegetables Used for Home Consumption.** (Arthur D. Holmes.)

*Some Results of Hormone Treatment of Field-Grown Tomatoes.* (Arthur D. Holmes, C. Tyson Smith, John W. Kuzmeski, and William H. Lachman.) The 1947 annual report discussed the food value of hormone-treated tomatoes which had been grown under greenhouse conditions during winter months. During the past year, the study was continued with hormone-treated tomatoes grown during summer months under outdoor conditions. Standardized Pritchard, Harris strain tomato seed was sowed April 10 in flats in the greenhouse, and the resulting well-developed plants were set out in an unshaded field on May 28. The plants were staked, pruned of all side branches, and fertilized with a 5-8-7 commercial fertilizer applied broadcast at the rate of 2000 pounds per acre. The tomato plants were divided into three groups: (a) hormone-treated plants, (b) emasculated and hormone-treated plants, and (c) controls. There were three replicates of each, or a total of twelve groups of tomato plants. The hormone was B-naphthoxyacetic acid applied with a nasal atomizer at a dilution of 50 parts per million. The applications were made directly into the individual flowers from time to time as fast as blossoms opened. Records were made of meteorological conditions during the growing period of 89 days; namely, hours of bright sunshine, inches of rainfall, relative humidity, and temperature changes. Analyses of representative samples showed that the three groups of tomatoes contained similar amounts of water, total solids, ascorbic acid, calcium, and magnesium. The controls contained the most potassium. The emasculated and hormone-treated tomatoes contained the least manganese but the most carotene, nitrogen, and phosphorus. However, judged by the results, the nutritive value of the hormone-treated tomatoes was not enough superior to that of the controls to justify their production.

*Influence of Light During Storage on Composition of Blue Hubbard Squash.* (Arthur D. Holmes, Albert F. Spelman, Charles J. Rogers, and William H. Lachman.) In this area, squashes may be stored during winter months in the dark in especially constructed storage houses, or, in some instances, in greenhouses fully exposed to bright daylight. Since Blue Hubbard squash is extensively grown in this area, and is typical of the hard-shelled varieties, it was chosen for a study of the possible influence of light during winter storage on the composition of squashes. The squashes were stored in a dry, well-ventilated laboratory attic, one-half in darkness and the others exposed to a known amount of illumination 24 hours per day for the experimental period. Typical squashes were assayed for water, carotene, ascorbic acid, reducing sugars, and total sugars at the

beginning of the experimental period and after 28, 60, and 102 days of storage. The composition of individual squashes varied, but there was no consistent difference in the composition of the squashes stored in the light and those stored in the dark. However, the amount of carotene, ascorbic acid, and reducing and total sugars found in the squashes at the end of the long winter storage showed that Blue Hubbard squashes stored either in the light or in darkness are a valuable source of constituents of the human diet.

*Storage Losses of Butternut Squashes.* (Arthur D. Holmes.) Butternut squashes, even though developed rather recently, have met with popular favor and are being grown in constantly increasing numbers in this area. They have high food value and are particularly rich in carotene, but they are generally poor keepers. Therefore, it seemed worth while to study storage losses of this variety of squashes under controlled conditions. Two comparable lots of Butternut squashes were stored in a dry, well-ventilated laboratory attic, separated only by a half-inch movable partition; but one lot was continually in darkness while the other was exposed to constant, controlled illumination. At the beginning of the nine weeks' experimental period, the squashes in the two lots averaged to weigh 1191 and 1193 grams. The loss in weight of the squashes stored in darkness was 20.3 percent, and for those stored in constant light, 15.8 percent. The loss of squashes through decay was 69.9 percent for those stored in darkness and 77.9 percent for those stored in the light. The decay was judged to be largely if not wholly due to black rot (*Mycosphaerella citrullina*). From the results of this preliminary study, it appears that exposure of squashes to continuous light during winter storage may influence the rate of spoilage by black rot.

**Yield and Composition of Ladino Clover as Influenced by the Quantity and Ratio of Potassium, Calcium, and Magnesium in the Soil.** (Mack Drake.) Ladino clover was grown in greenhouse pots on a Merrimac fine sandy loam soil, low in base exchange capacity (3.5 m.e. milli-equivalents per 100 grams of soil) and low in exchangeable bases. Calcium and magnesium, supplied at several different rates in exchangeable form as bentonites and also as dolomitic limestone, were combined with potassium supplied as potassium bentonite and as potassium chloride. Adequate amounts of nitrogen, phosphorus, sulfur, and boron were supplied to all treatments.

The check treatment yielded  $1\frac{3}{4}$  tons, while the highest yield of over  $4\frac{1}{2}$  tons of oven-dry hay per acre was produced in three cuttings by increasing the exchangeable bases as follows: calcium from 1.5 to 8.0 m.e.; magnesium from 0.12 to 4.0 m.e.; and potassium from 0.125 to 0.5 m.e. The calcium and magnesium content of the hay from this highest-yielding treatment was at a desirable level in the first cutting but decreased about one-half in the second cutting.

The combination of potassium bentonite and two tons of dolomitic limestone produced 4 tons of hay; and  $3\frac{2}{3}$  tons were produced by the use of three tons of dolomitic limestone with 120 pounds of  $K_2O$  initially and after each cutting.

The calcium and magnesium content of hay was higher and potassium was lower when the calcium and magnesium were supplied as dolomitic limestone than when supplied as bentonites. Also, the decrease in the percentage of calcium and magnesium in the second-cutting hay was considerably less when dolomitic limestone was used. Thus it appears that for highest yields and highest content of calcium and magnesium, these elements should be supplied both by the base exchange complex of the soil and as dolomitic limestone.

**The Nutrition of Apple Trees.** (Mack Drake, in cooperation with Pomology and Agronomy Departments.) Chemical composition of apple leaves and trunk



diameters of trees were used as a basis for pairing trees which constitute plots in laying out a mulch-fertility experiment with 15-year-old McIntosh apple trees. Chemical analyses were made of field-baled grass hay to be used for mulching. Variation in composition was reduced about one-half by breaking the bales, thoroughly mixing, and rebaling. Further information on this project may be found in the report of the Pomology Department.

#### **Yield and Composition of Forage Crops.** (Mack Drake and William G. Colby.)

In a study of the relative abilities of forage grasses to grow on soil low in available potassium, eleven common forage grasses were grown from January to June in greenhouse pots on a Merrimac fine sandy loam soil. This soil was low in available potassium, containing only 0.125 milli-equivalents of exchangeable potassium per 100 grams of soil (120 pounds exchangeable  $K_2O$  per acre). Adequate amounts of nitrogen, phosphorus, calcium, magnesium, and sulfur were supplied.

Kentucky blue grass produced the highest yield, 8.2 grams (oven dry). Using this value as 100, the relative yields were: timothy, 91; Reed's canary grass, 88; commercial orchard grass, 81; perennial rye grass, 76; red top, 71; late-maturing orchard grass, 70; tall fescue, 68; tall meadow oat grass, 67; meadow fescue, 66; and smooth brome grass, 47.

The potassium content of Kentucky blue grass was very low, 0.246 percent, while the smooth brome grass, which produced less than half as much dry matter, contained 0.41 percent potassium. All of the grasses except red top contained a lower percentage of potassium than smooth brome grass. Late-maturing orchard grass yielded less dry matter but contained one-tenth more potassium than commercial orchard grass, indicating a greater potassium requirement for the late-maturing type.

Large amounts of available potassium are required by the legumes, Ladino clover and alfalfa, since over 200 pounds of  $K_2O$  per acre may be removed annually by these crops. When the supply of available potassium is not maintained, grasses "crowd out," or replace, the clovers. Since Kentucky blue grass, timothy, orchard grass, red top, and Reed's canary grass produced considerably greater growth than smooth brome grass when grown on a soil low in available potassium, this may help to explain why these grasses usually crowd out alfalfa or Ladino clover and why smooth brome grass has shown a lesser tendency to crowd out these legumes.

#### **The Investigation of Agricultural Waste Products. 1. The Chemical Investigation of Lignin.** (Emmett Bennett.)

Polarigraphic analysis applied to certain organic compounds with ring structures has been helpful. Comparative polarigraphy of lignin was abandoned after obtaining the polarigraph of pure unmodified lignin.

Investigations have been conducted to determine by methylation procedures whether or not hydroxyl groups are involved in the simultaneous oxidation and nitrogen fixation reaction. Complete methylation essentially prevented the fixation of nitrogen. Previous oxidation and fixation treatments did not alter the compound enough to prevent a considerable degree of methylation. These results are interpreted as indicating that the phenolic hydroxyl groups were destroyed during oxidation and that the increase in percentage of methoxyl effected by methylating the oxidized product was due to the presence of alcoholic, not phenolic, groups. Therefore, the fixation of ammonia took place by way of the phenolic hydroxyl groups. Details of this investigation may be found in "Soil Science."

**Studies on The Quantitative Estimation of Hemicelluloses.** (Emmett Bennett.) The determination of hemicellulose, as published in *Analytical Chemistry* 20: 642, 1948, is dependent upon rather strict adherence to a standardized procedure. This involves an estimation of the extent to which lignin has been removed and a subsequent separation of holocellulose by filtration, which may result in the loss of hemicelluloses which have become somewhat solubilized. Attempts are being made to eliminate these losses and, at the same time, to cut the time of operation by producing the holocellulose and performing the rapid extraction of hemicelluloses with sodium hydroxide, all without filtration. Preliminary trials, employing techniques cited in the above publication, indicate that a separation of lignin, freed by sodium chlorite, may be removed from the final solution prior to oxidation with chromic acid. Since separations are eliminated until the end, the action of sodium chlorite must be stopped before the introduction of the alkali. Subsequent color changes in the final solution as a function of the chlorite must also be eliminated or made constant so that the spectrophotometric measurement of reduced chromate will be a true function of the quantity of hemicelluloses which have been oxidized. These details are now receiving attention. Preliminary trials indicate that a successful integration may be possible.

**Chemical Investigations of Hemicelluloses.** (Emmett Bennett.) Quantitative estimations of xylose in hemicellulose fractions from corn stalks have been successful. Xylose, usually the main constituent in polyuronide hemicellulose, is not readily determined as such but must be arrived at indirectly; hence, the adaptation of a method suitable for the major constituent is helpful. The procedure involves the formation of dibenzylidene dimethyl acetal of xylose, a white, felt-like, crystalline material which can be readily filtered and measured. Most other sugars do not react with the reagents used in this procedure. Accordingly, quantitative measurements have been made of xylose in the hydrolysates of hemicellulosic fractions.

Periodate oxidation of hemicelluloses has been studied in order to make chain length measurements of the different hemicelluloses. This reagent will react with the terminal and/or reducing groups and main chain residues connected through a 1-6 type of linkage. A consideration of these facts in the final calculations yields values which indicate that the chain length of hemicelluloses in corn stalks may range from about 10 to 30 anhydrous monosaccharide units of an average molecular weight of about 136. These values agree well with data obtained from different materials by other methods. They are yet to be compared with a measurement of different methyl derivatives. In the absence of such data, the evidence at hand seems to indicate that the 1-6 type of linkage in the polymers is nearly absent, and that linkages in the pentose units are probably of the 1-4 variety.

In general, the consumption of periodate in the oxidation of polysaccharides is a function of structure. Oxidation of hemicellulosic fractions in buffered media and at low temperatures indicates that the ratio of moles of periodate consumed to moles of carbohydrate oxidized was 1:1 in the chains of greater length and of firmer attachments; the shorter and more soluble chains utilized a lesser amount of periodate per mole of carbohydrate.

**Dental Caries.** (Julia O. Holmes.) This study, initiated in 1944, had as its ultimate goal the finding of methods of reducing or preventing tooth decay in man, particularly in the New England area where the condition exists in a rampant form. The study was based on the premise that susceptibility to dental

caries is determined by the diet, that some of the foods commonly eaten by man may contain an anticariogenic (tooth decay-preventing) factor, and that foods could be tested for this factor by feeding them to experimental animals as supplements to the standard cariogenic diet. No food has yet been found which would protect against the rampant tooth decay induced by this diet, but some of the findings support the theory that the diet may be an important determiner of susceptibility to dental caries.

The experimental animal used in the study was the Norway rat. Earlier reports were based on an examination for cavities on the grinding surface of the twelve molar teeth. In the work reported here, the teeth were examined under a microscope for early signs of decay in the deep fissures; and in evaluating results, both incidence and extent of decay have been taken into account. The method of preparing animals for this study, unless otherwise specified, was to feed healthy mothers the same ration of natural foods that is used for the entire breeding colony. This diet is satisfactory for good growth and for fairly good reproduction and lactation. At 21 days of age the young rats were placed on the experimental rations and fed ad libitum for eleven weeks. When two or more rations were to be compared, they were fed to littermate brother or sister rats. The standard cariogenic ration is composed of highly purified foods, adequate in protein, fat, vitamins, and minerals, and containing all of its carbohydrate (73 percent of the ration) in the form of fermentable sugars, either sucrose or dextrose. This ration allows the rat to grow well, maintain good health and vigor, and in a number of experiments supported good reproduction and fairly good lactation.

*Fermentable Sugars.*—The excessive consumption of sugar has almost invariably led to marked tooth decay. Of the 200 rats fed the standard cariogenic diet, only six were completely free of tooth decay. When the sugar was completely replaced by either raw or cooked starch, the rats experienced markedly less decay. Since tooth decay has occurred to a substantial degree in rats never having received sugar, it seems fair to conclude that, although excessive consumption of sugar aggravates dental caries, it is not the only cause and may not be the fundamental cause of tooth decay in the rat.

*Maternal Diet.*—Three different maternal diets were compared for their effect on tooth decay in the young rats: the standard cariogenic diet during pregnancy, fortified with 10 percent additional protein, in place of an equal amount of sugar, during lactation; the standard cariogenic diet without the additional protein throughout pregnancy and lactation; and the regular breeders' diet of natural foods. At weaning, the young were fed the standard cariogenic diet. The young of mothers receiving the breeders' diet had much lower scores, for both incidence and extent of decay, than either of the other groups. The group whose mothers had the additional protein came next; while in the group whose mothers had the cariogenic diet without the additional protein, tooth decay progressed so rapidly that it was necessary to terminate the experiment at eight weeks instead of eleven. These results point again to the influence which the diet exerts in determining susceptibility to tooth decay.

*High Protein Diets.*—Casein, a protein of milk, when fed in large amounts markedly retarded or completely inhibited tooth decay. This effect was obtained only when casein supplied from 35 to 50 percent of the total weight of the ration or from 34 to 47 percent of the total calories.

In order to determine whether this effect on caries was due to the casein, or to the reduction in sugar content of the ration which accompanied the increase in



casein, a diet was fed in which dextrin replaced sugar in an amount equivalent to the extra casein. While tooth decay was less than on the standard cariogenic diet, the reduction was not so great as was found in littermates receiving the high-protein diet. It is, therefore, apparent that some but not all of the beneficial effect of the high-protein diet was due to decreased sugar consumption.

Several of the individual amino acids of which casein is composed were fed in amounts equivalent to that in a ration containing 50 percent casein. None of these, when fed in conjunction with the standard cariogenic diet, had any retarding or inhibiting influence on the incidence or extent of tooth decay.

Animal proteins contain a factor now known as vitamin B<sub>12</sub>, necessary for growth of animals and for the prevention of pernicious anemia in man. A 50 percent casein ration is rich in this factor; but when it was fed in the form of liver extract or the "cow-manure factor", tooth decay was not reduced. Therefore the anti-cariogenic effect of casein-rich rations cannot be explained on the basis of the content of the "animal protein factor."

Casein which was digested by enzymes to a form in which the amino acids are freed from combination with each other and which was probably freer of contamination with other substances than was the undigested casein, was fed at a level of 50 percent. It was as effective as the undigested casein in inhibiting tooth decay.

*Urea.*—Crystalline urea, either fed in the drinking water or mixed in the standard cariogenic diet at levels of 1.5, 2.0, or 2.5 percent, partially inhibited tooth decay, but 0.3 percent had no retarding effect. These findings were obtained with rations containing small (14 percent) to generous (26 percent) quantities of casein. In an attempt to increase the body's output of urea (the end-product of amino acid metabolism) without introducing it into the oral cavity and thereby providing a potential alkaline reaction in the mouth, the amino acid arginine was fed alone and also with glutamic acid and glycine, in conjunction with the standard cariogenic diet. Although arginine not only gives rise to more urea than does any other one amino acid but also is concerned in the body's manufacture of urea, no retardation of tooth decay was observed.

*Crystalline Methionine.*—Methionine, a sulfur-containing amino acid, when fed in the crystalline form under certain conditions aggravated tooth decay. Its deleterious effect was greater when fed with a low (10 percent) protein ration than with a 15 percent protein ration. When added to a ration in which dextrin replaced all the sugar, it made the dextrin ration as cariogenic as the standard cariogenic ration. This latter finding of marked caries in rats fed sugar-free diets gives additional evidence that excessive consumption of sugar is probably not the fundamental cause of tooth decay. When methionine was fed along with all the other amino acids in the form of predigested casein, no deleterious effects were observed. This suggests that an amino acid imbalance may predispose to dental caries.

*Heredity.*—Three distinct strains of rats have been studied. The young rats from the three strains grew equally well when placed on the stock colony diet and presumably were in good health. These strains also grew equally well on the standard cariogenic diet, but showed marked differences in their susceptibility to tooth decay. Inasmuch as similar strain differences in susceptibility to decay have been reported by the Wisconsin investigators for a different species of animal, the combined findings suggest that in man, too, heredity may determine susceptibility to tooth decay.

*Glutamic Acid.*—Although glutamic acid neither accelerated nor retarded tooth decay, it did aid in the disintegration of the teeth, presumably by dissolution. The eroding effect appeared to be confined to the dentin and resulted in a deep cupping of the grinding surface, with the enamel walls of the tooth unaffected. This type of erosion appeared to be distinctly dissimilar to that found in rats fed cola-type beverages, acid fruit drinks, or solutions of sugar and acetic or citric acids, all of which dissolve both enamel and dentin on the tongue side of the tooth. The feeding of glycine and arginine together with glutamic acid did not nullify the dentin-dissolving effect of glutamic acid; but when all the amino acids were fed in the form of predigested casein, glutamic acid did not exert its eroding effect.

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THE CRANBERRY STATION  
East Wareham, Massachusetts  
H. J. Franklin in Charge

**General.** Severe drouth with high temperatures and an excess of sunshine in August curtailed the 1948 cranberry crop considerably, it being estimated that 3 percent of the fruit in Massachusetts and 10 percent of that in New Jersey was ruined by baking on the vines. In spite of this, Massachusetts produced 603,000 barrels, easily a record.

The Early Black fruit proved to have superb keeping quality. The Howes variety was only fair in this respect, due apparently to high November temperatures. A general forecast of the keeping quality was made by the Station in mid-June, and this seemed to be successful enough to justify further attempts of this kind in the years to come.<sup>1</sup>

**Injurious and Beneficial Insects Affecting the Cranberry.** (H. J. Franklin.) The third and fourth parts of the work on cranberry insects—dealing with the pests attacking the stems and roots—were completed. The insect and disease control chart was revised and brought up to date as usual.

In cooperation with the A. D. Makepeace Company, of Wareham, and the Farm Supply Service of the Eastern States Farmers' Exchange, of West Springfield, the Station made some study of DDT residues remaining on cranberries at picking time after summer treatments for fruitworm control. Residues of about two parts per million were found on fruit from areas sprayed with 3 pounds of 50 percent wettable DDT in 100 gallons of water, 400 gallons per acre, on July 22 and picked on August 22, 1948. The weather was generally very dry and sunny from the time the spray was applied until the berries were picked. The results of this study suggested that DDT should not be used on Massachusetts cranberry bogs later than mid-July. There seldom should be real occasion for such a late application anyway.

*Prevalence of Cranberry Insects in the Season of 1948:*

1. Fireworms were rather less abundant than usual during this season but, as usual, had to be treated on some bogs.
2. The cranberry fruit worm was about normal in abundance, but spotty—some bogs having none of the eggs and others a considerable number, as many as 89 eggs to 100 berries having been found on a bog at Hyannis.

<sup>1</sup>Mass. Agr. Expt. Sta. Bul. 450. 2. 1948.

3. The false armyworm was possibly more abundant than normal.
4. There was a widespread abundance of the cranberry weevil. This insect gave more general trouble than in any previous year in the writer's experience.
5. The cranberry spittle insect was widely harmful in Barnstable County, being more definitely troublesome there than in most years.
6. Mites were prevalent on a few bogs but were largely controlled by heavy rains.
7. Both hive bees and bumblebees were extremely abundant on the bogs throughout the cranberry flowering period everywhere.
8. The gypsy moth on the whole was about normal in abundance, being quite destructive in some sections but not giving much trouble in others. It was generally controlled very well on the cranberry bogs and their surroundings by the use of DDT.
9. No fire beetles were reported anywhere, and spanworms seemed less troublesome than usual.
10. The fall armyworm appeared in damaging numbers on a bog of the Smith-Hammond Company, in Carver, following removal of a grub flood on July 15. This is the first recorded appearance of this insect on a cranberry bog in Massachusetts. The worms were first discovered on August 3. Many of them were then an inch long.
- The fall armyworm also appeared in damaging numbers on a bog of H. F. Whiting, at Plympton, following removal of a grub flood. This species also appeared in large numbers on the Ware Bog of the John J. Beaton Company, in Plymouth, after removal of a grub flood, being associated in this case with rather larger numbers of the black cutworm. The fall armyworm and the black cutworm appeared together in abundance on the Decas Bog, at Mary's Pond in Rochester, following a grub reflow.
11. The cranberry girdler was notably less troublesome than usual.

**Frost Forecasts.** (H. J. Franklin.) Afternoon and evening forecasting of frosts for the cranberry bogs was sponsored by the Cape Cod Cranberry Growers' Association and continued as in previous years, there being 213 subscribers to the special telephone service in the seasons of both 1948 and 1949.

**Control of Cranberry Bog Weeds.** (C. E. Cross.) Over 200 experimental areas were treated and later studied for effectiveness of weed kill and possible injury to cranberry vines. In addition, nearly 100 commercial scale operations were to some extent supervised and the results studied. The following materials were used in varied concentrations and at varied rates of application: Sodium salt of 2,4-D, tri-butyl ester of 2,4-D, iso-propyl ester of 2,4-D, Stoddard Solvent (the product of five different refineries), kerosene, ferrous sulfate (both dry and in solution), sodium chloride (concentrated solutions only), and ammonium thiocyanate. A comprehensive study was made of the relation of various weather conditions to the effectiveness and selectivity of kerosene and Stoddard Solvent treatments in spring and summer.

During this last year, Stoddard Solvent has proved a cheaper and more effective killer of some bog weeds than kerosene. If it is sprayed as a fine mist on young grasses, sedges, rushes, and sand spurrey in April, it can be 100 percent effective, at 200 gallons per acre, and during this month causes no observable injury to cranberry vines on new or old bogs. It is most effective when sprayed under conditions of high humidity when the oil is slow to evaporate. Heavier dosages up to 400 gallons per acre are necessary to kill established tussocks of spike rush and wool grass. Asters are not easily controlled with Stoddard Solvent



until they are 6 to 8 inches high; but, since they are 10 to 12 inches high (on "early-drawn" bogs) by the time cranberry vines begin their seasonal growth, they can still be selectively controlled late in April or early in May by Stoddard Solvent sprays. Very heavy applications of Stoddard Solvent, 600-800 gallons per acre applied in late April, have given over 90 percent control of the small bramble. This is the first chemical treatment ever found that would control this *Rubus* selectively in cranberry bogs. Cranberry growers can use Stoddard Solvent safely late in May or early in June only during the first five days after the drawing of a late holding of the winter flood. Under these conditions, a mist spray of 300 gallons per acre gives effective control of loosestrife, a weed that appears more than normally abundant this year.

Weather and spraying studies have shown that both Stoddard Solvent and kerosene sprays are effective on moist or wet bogs, provided there is no standing water on the bog surface. Windy days, when the humidity of the air is low, are the best on which to spray kerosene late in the season. Some kerosene sprays applied in September and October, 1948, caused no cranberry vine injury, indicating that the fall treatment of bog weeds should receive further study.

The sodium salt of 2,4-D was the only member of the growth regulators tested that could be used safely on or adjacent to cranberry vines. It was further found that only the most concentrated solutions gave satisfactory control of loosestrife and then only before this weed had flowered. Late-season treatments with saturated solutions only contorted loosestrife plants temporarily and failed utterly in permanent control.

Esters of 2,4-D sprayed on shores of cranberry bogs as a form of chemical mowing injured cranberry vines to a distance of 30 feet, even though spraying was done with an on-shore wind which carried any drift away from the bog.

Concentrated solutions of sodium chloride (2 pounds per gallon of water) if sprayed lightly strip all the foliage from fireweeds and pitchforks without injuring cranberry vines even during the blooming period. Since these two annual weeds make a very rank growth and spread rapidly by means of their highly viable seed, it is advisable that growers use the above spray as soon as either of these weeds becomes noticeable on the bog.

Solutions of ferrous sulfate (1 pound per gallon of water) sprayed on pitchforks in the cotyledonary stage (but not later) proved highly effective and selective in killing this weed among cranberry vines.

**Winterkilling Studies.** (C. E. Cross.) Experiments with burlap covers to prevent winterkilling were set out again during the winter of 1948-49. Because of the mild weather all winter, no killing occurred even on unprotected cranberry vines. Leaf samples were regularly collected all winter and the cell sap of the leaves examined for its index of refraction. The sugar content of the sap from leaves covered with burlap was regularly, but only slightly, lower than from fully exposed foliage.

A rather extensive series of experiments was laid out and the cranberry vines sprayed with Dowax to determine the efficiency of this material in preventing winterkilling by reducing transpiration losses. The wax applied in November, 1948, had not been washed off by rains in June, 1949. Since winterkilling conditions did not materialize, it is not known whether or not this wax would have prevented injury to the cranberry vines. Routine sampling and testing of the leaves showed a slight but consistent lowering of the sugar content in wax-sprayed foliage, indicating at least some impairment of the normal physiology of the vines. A further significant observation was made in the spring of 1949. Frost injured all the cranberry vines in the bog containing the wax spray experi-

ments, but only the areas sprayed with wax were injured severely enough to deprive the vines of a crop prospect. It is concluded, therefore, that the wax spray either stimulated a premature growth in the spring or that it somehow sensitized the vines slightly to frost. The difference in sensitivity to frost between waxed and unwaxed vines was estimated as 2° F.

Some tests with wax are being set out this summer to determine the value of such a technique in preventing desiccation during drouth periods.

**Soil Water Studies.** (F. B. Chandler.) Studies of soil water indicate that the vines dry out in some bogs with a fairly high water table; while in other bogs with a much lower water table, there is no evidence of injury. A new manometer liquid has been used in tensiometers, and new cups have been designed.

**Fertilizer Requirements of Cranberry Plants.** (F. B. Chandler and William G. Colby.) Fertilizers with a 1-2-1 ratio produced greater yields of cranberries, and the vines had better color than where a 1-1-1 ratio was used. Applications of nitrogen at the rate of 80 pounds per acre annually are too great, regardless of the ratio of other elements. For some bogs and for the McFarlin variety, 40 pounds per acre annually is too great. Urea-form (a new nitrogen fertilizer) appears to be a very satisfactory source of nitrogen for cranberry bogs. During the past year, a response to potassium has been observed on two bogs. In one bog, the uprights had a better color where a mixture of minor elements had been applied.

The plots previously treated are being continued, and in addition plots have been treated to study the best method of applying phosphorus. Studies are being made with liquid fertilizers applied in the water for frost flow or flash flood; also, in sprinklers and applied with the fungous sprays.

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## DEPARTMENT OF DAIRY INDUSTRY

D. J. Hankinson in Charge

**Sanitizing Agents for Dairy Use.** (W. S. Mueller.) The following progress has been made:

1. *A Method for Evaluating the Sanitizing Efficiency of Germicides Proposed for Sanitizing Food Utensils.* (W. S. Mueller.) The method which is described in the last annual report has an end point of somewhat less than 100 percent kill. This method has been improved so that it is now possible to accurately determine 100 percent kill in testing germicidal potency of most germicides.

2. *The Effect of Certain Metallic Ions on the Germicidal Activity of Quaternary Ammonium Germicides.* (W. S. Mueller and D. B. Seeley.) Among the problems that have arisen in the use of quaternary ammonium germicides is their incompatibility with certain minerals found in water supplies, certain chemicals employed in cleaning agents, and organic matter encountered in cleaning procedures. The interference pattern of these, as well as other metallic ions, on the action of a quaternary germicide has been investigated. Valence and pH were found to be the two most important factors determining the interfering power of a cation. Monovalent, divalent, and trivalent ions had interfering powers approximately in the ratio of 1:100:10,000 respectively. When adjusted to pH 7, the cations appeared to lose their inactivating effect. Atomic weight had little or no relation to inactivating power. Five times as much quaternary was required for approximately 100 percent kill at pH 3 as at pH 10. The work up to now indicates that the metallic ions interfere by competing for the cell surface, thus blocking the cation of the germicide.

3. *New Developments in Sanitizing Teat Cups.* (W. S. Mueller and D. B. Seeley.) The results of this study were published in *Hoard's Dairyman*, Vol. 93, No. 21, pp. 807, 812, November 10, 1948.

**Improving the Flavor and Keeping Properties of Dairy Products.** (W. S. Mueller and E. J. Finnegan.) An apparatus called the "Stinkometer" has been used in conjunction with the Swifts Fat Stability Apparatus for investigating the spoilage of butterfat by oxidation. The correlation between peroxide values and oxidized flavor in butterfat is not close. As determined with the "Stinkometer", great differences were observed in the amount of volatile reducing substances produced from fresh and oxidized butterfat. The significance of these observed differences has not been evaluated.

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## DEPARTMENT OF ECONOMICS

Philip L. Gamble in Charge

**Transfer of Ownership and Its Effect on Agricultural Land Utilization.** (David Rozman.) Records on transfer of ownership and changes of land utilization have been obtained in seven towns scattered throughout the State: Mendon and New Braintree in Worcester County; Amherst in Hampshire County; West Newbury in Essex County; Halifax in Plymouth County; Berkley in Bristol County; and Colrain in Franklin County. The record of transactions covers a period of nine years, from 1940 up to and including 1948. The collection and examination of land transfers have been completed for the entire period under investigation except for portions of 1947 and 1948 for which additional data are being gathered.

The frequency of land transfers and changes of land ownership in all seven towns for the war period and the first post-war year are in general similar to the situation reported earlier for the first three towns. The total number of transactions has shown an upward trend throughout the period, although there was a slight reversal of this movement in 1945. In the first post-war year the number of transactions in all these towns was 143, compared with 89 in 1940. The total acreage involved rose to 6,296, compared with 3,711 in the earlier year. Of the 89 transactions in 1940, 45 involved land used exclusively for agriculture at the time of transfer, either on a full-time or a part-time basis. In 13 cases the change of ownership of agricultural land involved also a change in land utilization; 3 full-time farming units were reduced to a part-time basis; and 8 farms were entirely removed from agriculture. On the other hand, in 10 cases, non-farming land was transformed into operating farming units. In the first post-war year, 1946, out of a total of 143 transactions, 81 involved land used for agricultural purposes prior to change of ownership. In 6 cases full-time farming was changed to part-time farming, and in 20 cases full-time farms were transformed to non-agricultural use. Against this, in 10 cases non-farming land was taken up for part-time farming, and in 4 transactions non-farming land was developed into operating farm units.

In comparing these two periods it appears that although a movement between agricultural and non-agricultural use of land has been significant in both cases, in the first post-war year the loss of land from agriculture was on a greater scale than formerly. While this process may not be confirmed by the analysis of data for later years, withdrawal of land from Massachusetts agriculture is still proceeding on a significant scale. On the other hand, in a number of cases additional land was purchased by farm operators to be added to their existing farm units.



This was accompanied by a considerable amount of land improvement and land reclamation carried on by farm operators with a view to bringing their farms to greater efficiency, from the standpoint of both size and better utilization of land resources. Soil conservation practices are being adopted on an increasing scale, especially on the farms which have been transferred within the last few years.

In connection with the consideration of the general trend of Massachusetts agriculture, data were gathered on agricultural production for 1948 and an agricultural program was outlined for 1949.

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## DEPARTMENT OF ENTOMOLOGY

Charles P. Alexander in Charge

**Investigation of Materials which Promise Value in Insect Control.** (A. I. Bourne and W. D. Whitcomb.) Work in connection with the cooperative project with the Dow Chemical Company was continued in 1948, both at Amherst and at Waltham.

Dormant application of both the experimental materials D-289 and D-542 gave practically complete control of black aphid on sweet cherries, as well as the scale *Lecanium quercifex* on cultivated blueberry.

Adverse weather conditions which delayed egg deposition by pear psyllas until buds were beyond the point of safe use of D-289 neutralized tests on psylla eggs in 1948. Application was delayed until buds were so far opened that the basal protective leaves on the fruit buds were killed and some of the sepals were scorched.

Tests of parathion against red mites were made to determine its value in different applications of the season's schedule. Parathion proved very toxic to active stages of the mites but had no effect on eggs, and its period of effectiveness was quite limited. In late summer application, parathion and DN-111 showed about equal effectiveness, but from previous experience DN-111 has greater residual effect.

In 1948 it developed that there were more overwintering eggs of red mite than most growers thought, and where no dormant treatment was applied some bronzing occurred by mid-June. A considerable build-up of red mite, sufficient to cause serious bronzing, was noted in late July and early August, but the mite population decreased very rapidly thereafter.

Frequent observations showed that moderate to heavy infestations of oyster shell scale on lilacs were very successfully checked by the application of Dinitro spray in dormant application.

**Control of Red Mite.**—(W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) At Waltham the summer infestation of European red mite varied from 12 to 25 mites per leaf on August 9. Sprays were applied on that date and the reduction of mites per leaf was determined four and eleven days after treatment.

The most effective treatments, which gave complete control after four days and prevented a significant increase of mites for eleven days, were DN-111 (Dow) 1 pound—100; Vaportone XX (Cal. Spray Chem.) 1/3 pint—100; and 25 percent parathion wettable powder (Amer. Cyanamid) 1 pound—100.

Other experimental materials which gave good control after four days but failed to prevent later infestation are: Syndeet 30 (U. S. Rubber) 1 quart—100; Dimite (Sherwin-Williams) 1 pint—100; and IN-4200 (DuPont) 1 pint—100.

None of the materials caused any foliage injury when followed by abnormally hot, dry weather.

**The Value of Control Measures to Supplement the Standard Spray Program for Apple Pests in Massachusetts.** (A. I. Bourne, in cooperation with the Departments of Pomology and Plant Pathology.) Tests were run in a block of the Experiment Station orchard containing the two varieties, McIntosh and Baldwin. A lead arsenate schedule was followed throughout the season, with a combination of Fermate  $\frac{1}{2}$  pound and micronized sulfur 3 pounds as the fungicide.

The standard schedule of applications recommended for apples in this State was followed, including two pre-blossom sprays, calyx, and five cover sprays. For the first time the application previously designated "Emergency A," interposed between the 2d and 3d cover sprays and timed especially for codling moth control, was incorporated in the regular State schedule and became the 3d cover, scheduled normally to be applied about June 20. Lead arsenate was used in the pink and 4th cover sprays at 3 pounds; in the calyx, 1st, 2d, and 3d cover sprays at 4 pounds; and in the 5th cover at 2 pounds per 100 gallons (for maggot control).

McIntosh at harvest showed 92 percent fruit free from insect or disease blemishes; 1 to  $1\frac{1}{2}$  percent scarred by curculio;  $1\frac{1}{2}$  to 3 percent damaged by codling moth; 2 to 3 percent damaged by apple scab; and 2 percent scarred by red bug.

In plots where parathion (at 12 ounces of 25 percent wettable powder) was applied in the pink spray, fruit showed 2.8 percent injury by red bug. When this material was in the calyx spray, the amount of damage was reduced to a trace (6 apples in 1800). Fruit from unsprayed checks in the same block showed 34 percent injury by curculio, 66 percent by codling moth, 40 percent by apple scab, and 6 percent by red bug. In the portion of the orchard where parathion was applied, no appreciable infestation of either apple aphids or leafhoppers developed during the season.

*Red Mite Control with Parathion.*—No dormant treatment was applied in this orchard. Between the pink and calyx sprays a moderate infestation of red mite developed. On May 19, between the pink and calyx sprays, examination showed that in the plot where parathion was included in the pink application, one specimen of red mite was found on 25 spur clusters. Many basal leaves showed dead and shriveled mites and a few dead aphids. No living aphids were found on these trees. In the remainder of the orchard, red mites were found at the rate of 1161 for 25 spur clusters. A few eggs were found also, and a moderate infestation of aphids had developed. Each succeeding application of parathion (calyx, 1st and 2d cover) reduced red mite to a very low level; although, in every plot except where parathion was used in the pink spray, a moderate number of eggs could be found.

Hot dry weather during the summer apparently favored mite development, and by late July foliage in parts of the orchard began to show considerable bronzing. Counts made July 22 showed 4463 mites on 50 leaves in that section where no miticide was used, and serious bronzing was present. Where parathion was applied in pink spray only, counts showed 108 mites per 50 leaves and no bronzing. Where parathion was used in the calyx spray only, 6185 mites per 50 leaves were found and the foliage was seriously bronzed. Where parathion was applied in calyx and 1st or 2d cover sprays, mite infestation was 240 per 50 leaves and no bronzing was noted.

Apparently the timing was a determining factor. Parathion in the pink spray evidently eliminated the mites after the overwintering eggs had hatched and before mites had matured and deposited eggs for later broods. Parathion showed little if any effect upon eggs, and its period of effectiveness apparently was not long enough to kill many young mites from eggs present at the time of application.

*DDT.*—In the orchard in which tests of DDT were conducted, row 5 received DDT in the pink spray; DDT 2 pounds (50 percent wettable powder) plus lead arsenate 2 pounds in the calyx, 1st, 2d, and 3d cover sprays; lead arsenate in the 4th cover; and 85-15 sulfur-lead dust in the 5th cover. Row 6 received no insecticide in the pink spray; the same schedule as row 5 thereafter. Row 7 received DDT 2 pounds plus lead arsenate 2 pounds in the calyx and 1st cover; lead arsenate thereafter. Micronized sulfur was the fungicide used (6 pounds per 100 gallons). The remainder of the orchard was given the routine schedule.

Examination of McIntosh at harvest showed that in the section of the orchard which received the standard schedule of DDT and lead arsenate in calyx and 1st cover, and lead arsenate thereafter, curculio damage ranged from 1.7 to 2.2 percent; 10 to 11 percent of the fruit showed codling moth injury (much of which was late season "sting"); and slightly more than 1 percent red bug damage. Where DDT and lead arsenate were used in calyx, 1st, 2d, and 3d covers, 89.5 percent of the fruit was free from insect blemishes. Curculio damage was held to 1.6 percent; codling moth to 7 percent (mostly late "stings"); and red bug scarred 2 to 3 percent. Fruit from the trees which received DDT in the pink and a schedule of DDT plus lead arsenate thereafter showed equally good control of curculio and codling moth, and only 1 apple in 550 examined showed scarring by red bug.

Apple scab was held to a very low figure by the wettable sulfur and Fermate combination used with the insecticides.

*Mist Blower.*—A portion of this orchard was set aside for tests of a full season's spray program with a commercial mist blower. Examination of McIntosh at harvest indicated that, in the sections where the mist blower was used, very little scab was to be found on harvested fruit (none where micronized sulfur was the fungicide, and only 6 apples in 750 on the trees receiving Fermate). Insect damage was somewhat greater than where hydraulic spraying was done. Curculio damage ranged from 6 to 7.5 percent; codling moth, 9 to 20 percent; red bug, 0.6 to 1.4 percent; and miscellaneous minor pests, 2 to 3 percent; with 70 to 82 percent of the apples free from pest blemishes.

While the degree of control of insect pests in general fell slightly below that following the conventional spraying, and in some cases was considerably inferior to that in the rest of the orchard, the results were somewhat surprising. When it is recalled that the mist blower type of machines was developed primarily for forest and roadside spraying, and that adaptations for orchard requirements are still very much in the experimental stages, the results obtained seem promising. Further adaptations to allow more flexibility in application and more accurate coverage are necessary. This was indicated by the results secured on overwintering eggs of European red mite from delayed dormant application of oil sprays by both conventional equipment and the mist blower. Counts showed 277 mites hatched on 25 bud clusters in the check row; 5 living mites following the application by power sprayer (8 cluster nozzles); and 70 mites following the application by mist blower.

**Control of Plum Curculio in Apples.** (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) In 1948, the cool, rainy weather in May and early June concentrated curculio activity into a few critical periods when effective sprays were applied. Under these conditions, the insecticide formulations were more effective than in other seasons.

The standard formula of lead arsenate 2 pounds and 50 percent DDT wettable powder 2 pounds in 100 gallons protected 98.69 percent of the apples from damage



by the plum curculio, and justified its recommendation in the apple spray schedule. When a platelet form of lead arsenate was substituted for the regular lead arsenate in this formula, the control was even better.

Among the new materials which gave excellent control of plum curculio, in the following amounts per 100 gallons of water, are: 50 percent methoxychlor wettable powder 2 pounds plus lead arsenate 2 pounds; 50 percent chlordane wettable powder 4 pounds; 25 percent parathion wettable powder 2 pounds; and 50 percent chlordane wettable powder 2 pounds plus 50 percent DDT wettable powder 2 pounds. All of these formulas were more effective by about 10 percent than the former treatment of lead arsenate 4 pounds.

A chlorinated camphene (Toxaphene 25 percent wettable powder) at 4 pounds was slightly less effective, and caused a poor finish on the apples. Benzene hexachloride in two different formulations was the least effective even when combined with lead arsenate.

Of the new materials, methoxychlor appears to be the most practical. Parathion controls other pests equally well and has much promise if it is effective at lower concentrations. Chlordane, like benzene hexachloride, is not satisfactory for the control of codling moth in apples or oriental fruit moth in peaches.

**Apple Maggot Emergence.** (W. D. Whitcomb, Waltham.) Although fly emergence was later than the average, the survival of maggots in the soil was 58.5 percent, which is higher than in many seasons and reflects the excellent conditions for insect hibernation provided by the heavy winter snowfall.

The first fly emerged in the cages on July 4. Emergence reached 25 percent of the total on July 20; 50 percent on July 26; and 75 percent on July 31. The peak of activity was about ten days later than in recent years. The last fly emerged August 20, and flies were active in unsprayed apple trees until October 12.

**Insecticides for the Control of the European Corn Borer.** (A. I. Bourne.) Relatively cool weather during early spring retarded seasonal development considerably in late April, while continued cool and dry weather in early May still further retarded development of overwintering larvae. More frequent rains and more normal temperatures following the first week of May promoted more rapid pupation, and by May 24 approximately 50 percent of the larvae in the old stalks had pupated. There was very little evidence of winterkilling of the larvae.

Continued cool weather, especially at dusk, and frequent rains had a depressing effect on moth activity and moth emergence was slow, and a very slight amount of egg deposition was noted in the field. Since these weather conditions similarly checked the appearance and growth of corn itself, the relation between development of the insect and the corn was about normal.

Egg masses began to be noted in increasing abundance after June 20, and by June 26 evidence of hatching in the near future (black spot stage) was general. The first application of insecticides was made in test plots at Gate Hill on June 28 and was followed by applications at seven-day intervals.

Records of damage, based on tassel infestation and breakage, made previous to harvesting showed that of the sprays, DDT and parathion gave nearly perfect protection; derris and Ryanex plots showed moderate breakage; and more than 50 percent of the plants in the check plots showed infestation. Of the dusts, DDT, parathion, and Ryanex gave from 92 to 100 percent protection. Studies of stalk infestation at this time showed an average of from 2 to 2.4 borers per plant on untreated corn.

Records of the corn in the experimental plots were taken from the pickings made August 4, 5, and 6. In the plots sprayed with DDT and parathion 98-99 percent of the ears were free from any trace of injury; 91 percent of the ears in the derris plots were clean; and 96 percent of the ears in the plots sprayed with Ryania Concentrate were clean. In the dusted plots, no infested ears were found following parathion and Ryanex, and 98 percent of the crop in the DDT-dusted area was clean.

In the check plots, 81 percent of the ears showed no borer injury, indicating a rather light infestation. This was in line with conditions generally in this area and was attributed in large measure to the unfavorable weather conditions which prevented normal activity of the moths during the period of normal egg deposition. In parts of Hampden County and in southeastern Massachusetts where both growth of corn and development of the insects coincided with more normal and favorable weather conditions during the oviposition period, the infestation was much heavier and in some fields damage was extensive.

While the damage in the check plots caused by the first brood corn borer larvae, based solely on relative infestation of ears, would indicate a relatively light infestation; a comparison based on percentage of first-grade marketable corn indicates more accurately the loss caused by the insect. In the Ryanex-treated plots, 79-80 percent of the ears were of Grade 1 quality; in the derris and parathion plots, 80 percent; and following DDT, 94 percent. In the untreated check plots, only 65 percent of the harvested ears were of first grade in size and quality.

**Potato Spraying Experiments.** (A. I. Bourne.) The experimental plots were planted May 6. The field was first sprayed on June 17 when plants were 3 to 4 inches high, and 14 applications were made up to September 15. The applications after late August were for the protection of new growth from late blight, which was generally prevalent on both tomatoes and potatoes. The potatoes were dug October 14 and 15.

Flea beetles were somewhat late in appearing and were not abundant until after mid-June. A very heavy second brood appeared in late July and continued until about mid-August. Leafhoppers were never abundant in the field. Potato aphids threatened to become serious in late July and early August, but nicotine sulfate in two applications on July 28 and August 4 stopped the attack.

Observations on the seasonal abundance of flea beetles were made (by Jose Terrazas, a graduate student) at weekly intervals throughout the season, and indicated the striking effectiveness of DDT. DDT wettable powder appeared to give more lasting protection to the plants than DDT in the form of emulsion, although both seemed to kill beetles readily. The greater persistence of the dry wettable form appeared to build up an accumulative protection, and yield records reflected this difference.

The yield in the DDT (w.p.) plots was 508.13 bushels per acre, 67 bushels over that in the Bordeaux plot. In the DDT (emulsion) plots the yield was 43 bushels per acre greater than where Bordeaux alone was used. In all plots, 93 to 95 percent of the crop was of Grade 1 size and quality, and in the entire field only slightly more than 2 bushels (128 pounds) were discarded for small size or quality (imperfections, etc.).

**Control of Onion Thrips.** (A. I. Bourne.) Warm weather in early April favored early planting of onion sets and a considerable portion of the acreage in the Valley was planted to sets during the early part of that month. A reversion to cooler weather toward the middle of the month slowed down all seasonal development and not much further planting took place until the last of April and early May.

Sets were used in the test plots and were planted in late April. Growth was somewhat retarded by cold weather and frequent rains in May and continuing into June.

Thrips were rather late in appearing and developed rather slowly during June, and no infestation of any consequence developed until middle to late July. Many of the early harvested fields in the Valley showed no serious evidence of attack and very few thrips. Some "blast" developed in parts of the Valley and as a consequence some fields of sets were pulled early and onions were small. The crop in fields which escaped blast was harvested at the usual time and was of good quality.

Black Leaf 40 with pine tar soap spreader, DDT wettable powder and emulsion with Triton wetting agent gave perfect kill of thrips; Ryanex and Triton gave 90-95 percent kill. Some slight build-up in population occurred during a 7-day period following Black Leaf 40 and parathion; but chlordane and Ryanex still held thrips to a minimum, as did both types of DDT.

In dust application, DDT, parathion, chlordane, and Ryanex gave a very high immediate kill of thrips. After 7 days, DDT and parathion dusted plots showed only slight increase in population; but chlordane and Ryanex dusts had apparently lost much of their effectiveness in this time.

**Odor and Taste Contamination of Vegetables from Soil Treatment.** (W. D. Whitcomb, W. J. Garland and C. S. Hood, Waltham.) Studies of taste contamination of vegetables grown in soil treated with benzene hexachloride and chlordane were continued with plots treated in the spring and fall of 1947, and the spring of 1948.

No off-taste flavor or other detrimental effect was observed in onions, parsnips, beets, turnips, or radishes grown in this soil. Taste tests were made by the Department of Food Technology and by the Waltham Field Station on carrots and potatoes.

On boiled carrots, there was no significant off-flavor taste when the carrots were grown in soil treated with 2 or 5 pounds of chlordane, or 2 pounds of regular BHC, per acre; but soil treated with regular BHC at the rate of 5 pounds per acre produced definite taste contamination in boiled carrots.

Potatoes grown in chlordane-treated soil showed no significant off-flavor taste at the 2 pounds per acre dosage; but a slight contamination from the 5 pounds per acre treatment was detected in boiled potatoes by about one half of the tasters.

Where benzene hexachloride was used, the 5 pounds per acre dosage caused noticeable off-flavor taste in all cases, and this dosage is obviously unsatisfactory on potatoes. The 3 pounds per acre and 2 pounds per acre dosages caused noticeable contamination in some cases and not in others. Definite off-flavor taste occurred often enough to make the treatment impractical.

Applications of these insecticides in the spring just before planting caused the most off-flavor contamination in potatoes, but noticeable contamination was found where soil had been treated in the spring and fall previous to planting.

In three of four tests, heavily contaminated potatoes used as seed produced normal potatoes with negligible off-flavor taste.

With a few minor exceptions, off-flavor taste was detected more quickly and strongly in baked than in boiled potatoes.

**Control of Squash Vine Borer.** (W. D. Whitcomb, W. J. Garland, Waltham.) The natural field infestation of vine borers in sugar pumpkin, summer squash, Buttercup squash, and Blue Hubbard squash was 5.07 borers per vine. Three applications of insecticides were made at weekly intervals beginning July 12.



The best control and protection was obtained with a high setting point DDT (Vine-Safe, Sherwin-Williams Co.). A spray of 50 percent wettable powder, 2 pounds in 100 gallons of water reduced the infestation 64 percent, and a 3 percent dust 63 percent. Standard DDT as a 3 percent dust gave good protection but caused some leaf injury to the plants. Chlordane, chlorinated camphene, and a combination DDT-pyrethrum dust were less satisfactory.

**Biology and Control of the Celery Plant Bug.** (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) The field infestation of *Lygus campestris* in the experimental planting was so light in 1948 that results from insecticide treatment were not significant. All treatments prevented injury by this pest for 30 days, and the untreated plants did not have serious damage. Dusts containing DDT regular, DDT high setting point, chlordane, parathion, and chlorinated camphene were applied and none of them caused noticeable plant injury.

Samples of specimen stalks collected 20 days after treatment were analyzed for DDT residue by the Regulatory Service of the Agricultural Experiment Station. An excessive amount of DDT was found on the leaves but a small amount on the stalks. Sprays using  $\frac{1}{2}$  and 1 pound of DDT in 100 gallons of water deposited a residue about equal to the informal tolerance of 7 p.p.m., while dusts left an excessive residue. These residues indicate that the methods of application must be changed, or a less toxic insecticide must be used.

**Control of Cabbage Maggot.** (W. D. Whitcomb and W. J. Garland, Waltham.) Because of continued cool weather and excessive rainfall during the active season of the cabbage maggot, the natural infestation in the untreated cabbage plants at Waltham was 45 percent, which is about 35 percent below normal. Under these conditions both 3 percent chlordane dust and benzene hexachloride dust 3 percent gamma isomer gave perfect commercial protection in one and two applications. A BHC dust containing 3 percent gamma isomer only, and one containing 3 percent gamma isomer plus other isomers were equally effective. A spray prepared with 3 pounds BHC wettable powder containing 46 percent gamma isomer in 100 gallons of water gave good commercial control but was slightly less effective than the better dusts. A 5 percent chlorinated camphene (Toxaphene) dust was the least effective of the treatments and was considered unsatisfactory. In the plots which received the most effective treatments, 90 to 98 percent of the plants produced marketable heads.

Chlordane is less likely to contaminate the soil with an objectionable residue than benzene hexachloride and is preferred where carrots, beets, or potatoes are likely to be grown in the next one or two years.

**Biology and Control of the Grape Cane Girdler.** (W. D. Whitcomb and C. S. Hood, Waltham.) Although the first activity of the grape cane girdler beetles was observed May 29-31, cool wet weather prevented further activity until June 14. Under these conditions, grape canes grew slowly with shorter nodes, and more than the usual number of grape bud clusters were cut by the beetles. Observation on 29 cut canes showed that 75 percent of them were girdled behind at least one cluster of grape buds and on 35 percent of the girdled canes two or more clusters were damaged.

Applications of insecticides to outdoor grape vines at weekly intervals reduced the number of girdled canes 90 to 95 percent. A commercial dust containing DDT, BHC, and sulfur was the most effective during clear weather but gave no protection after a rain. Lead arsenate and BHC gave good control and more protection than the dust.

In 1948, protection by insecticides was necessary from June 14 to July 3.

**Biology and Control of Common Red Spider on Greenhouse Plants.** (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) Evaluation studies of the new organic phosphate insecticide, parathion, showed great efficiency for the material as a control for the common red spider mite on greenhouse plants.

On carnations a spray containing 2 ounces of 25 percent wettable powder in 100 gallons of water, a dilution of 1-25,600 of actual toxicant, killed 77.6 percent of the spiders. When  $\frac{1}{4}$  pound was used, 90.9 percent of the spiders were killed; and the  $\frac{1}{2}$  pound dosage gave 97.6 percent mortality. Complete control resulted from a dosage of  $\frac{3}{4}$  pound in 100 gallons, compared to a natural mortality of 14.01 percent on unsprayed plants. In a practical demonstration on benched carnations, a spray of  $\frac{1}{2}$  pound of 25 percent parathion wettable powder in 100 gallons of water killed 98.3 percent of the spiders three days after application, and 100 percent after five days. The natural mortality was 3.05 percent.

The ovicidal activity of parathion in this form is low, but residual action remains for at least 10 days to kill newly hatched nymphs.

**Study of Naphthalene and Similar Compounds as Greenhouse Fumigants.** (W. D. Whitcomb and W. J. Garland, Waltham.) Greenhouse fumigation with naphthalene has been replaced generally by application of organic phosphates in aerosol form, and the work on this project was done with aerosols.

On cucumbers, severe injury resulted from applications of 10 percent parathion in methyl chloride. When 10 percent acetone was added to this formula, greenhouse cucumbers were treated seven times at weekly intervals with no significant injury to the plants. One application gave complete control of the common red spider mite. It was found necessary to remove honey bees from the greenhouse for three days in order to avoid serious losses.

On carnations and roses, a 10 percent parathion-acetone aerosol killed 99 to 100 percent of the common red spider in each of eight different tests, when used at the recommended rate of 1 pound to each 50,000 cubic feet. Residual action against red spider was effective for five days after application.

In a long list of ornamental plants which were exposed, only three species of *Crassula* were injured.

**Study of Euonymus Scale and Its Control.** (W. D. Whitcomb and C. N. Warner, Waltham, in cooperation with the Bartlett Tree Expert Company.) Studies with the *Euonymus* scale were continued throughout the season.

The oviposition period of this scale extended for about a month. Eggs of the first generation were laid from June 10 to July 13, and those of the second generation from August 24 to September 20. Hatching took place in about a week and the height of crawler activity was the last week in June and again the first week in September.

On potted plants under laboratory conditions complete control was obtained with the following formulae:

Oil emulsion (Volck) 2 percent + 40 percent nicotine sulfate 1-800

Oil emulsion (Volck) 2 percent + 50 percent DDT wettable powder 2 pounds-100

Oil emulsion (Volck) 2 percent + 25 percent parathion wettable powder 1 pound-100

50 percent DDT wettable powder 2 pounds-100 + 25 percent parathion wettable powder 1 pound-100

All of these sprays were effective if applied within 10 days after the crawlers had hatched and settled. The sprays containing DDT were also effective if applied within 10 days before the crawlers hatched and crawled over the residue.

**Spraying to Prevent Twig Feeding by the Smaller European Elm Bark Beetle.** (W. B. Becker.) Several types of DDT and other new insecticides were applied by different types of spray equipment to prevent twig feeding on live elms by the smaller European elm bark beetle, *Scolytus multistriatus* Marsham. The testing method was the same as that described on pages 41-42 of the Annual Report for the Fiscal Year Ending June 30, 1947 (Bulletin 441).

1. *With Small Compressed Air Sprayers.*—All sprays used in this equipment were applied thoroughly at close range to low-growing branches of elms to obtain maximum coverage. A benzene hexachloride emulsion<sup>1</sup>, used at 1/8, 1/4, 1/2, and 1 percent, did not give so good or so lasting protection as has been obtained with DDT emulsions of comparable strengths. When applied in the spring just after the young leaves had unfolded, serious foliage injury resulted at all concentrations.

A 1 percent Toxaphene emulsion also failed to have so lasting an effect as a 1 percent DDT emulsion<sup>2</sup>. A 1 percent DDT emulsion had a more lasting effect than a DDT wettable powder at a comparable concentration. The addition of soybean flour<sup>3</sup> or polyethylene polysulfide<sup>4</sup> to the 50 percent DDT wettable powder at the rate of 1 to 4 by weight seemed to prolong its effectiveness slightly, but the residue still was not so lasting as that of a DDT emulsion of comparable strength. No important spray injury resulted from mid-August applications of these materials, but none of them were effective for more than a few days when applied at the low concentrations employed against leaf-feeding insects.

Three 1 percent DDT emulsion formulations<sup>5</sup>, developed by the United States Bureau of Entomology and Plant Quarantine for use against elm bark beetles on elm during the foliage season, and a 50 percent DDT wettable powder<sup>6</sup>, used at the rate of 16 pounds per 100 gallons of spray, were sprayed on other species of shade and ornamental trees in mid-August to determine whether these elm bark beetle sprays would injure other trees on which the spray might fall. At the time of spraying, the air temperature was 76°F., the relative humidity 66 to 65 percent, the sky hazy, and the air calm. No spray injury was noticed on foliage the remainder of the season on white ash, purple beech, red, silver, and sugar maples, red and white oaks, or black walnut (broad-leaved trees); or on arbor vitae, eastern hemlock, European larch, or red, Scotch, and white pine (needle-bearing trees). However, formulations 1, 2, and 3 injured the foliage of Norway maple, and formulation 2 injured Norway spruce in these tests.

2. *With High-Powered Hydraulic Sprayers (60 gallons a minute capacity).*—Dormant applications of 2 percent DDT sprays (twice the strength of the emulsion formulations 1, 2 and 3 in the previous section, as well as one prepared with Geigy's Gesarol E 25 emulsion) gave good protection to the tops of 55 to 70 foot elms for two months. An equivalent concentration of Geigy's Gesarol Ak 50

<sup>1</sup>John Powell & Company.

<sup>2</sup>Geigy's Gesarol E 25 emulsion.

<sup>3</sup>Spraysoy.

<sup>4</sup>Good-rite p.e.p.s.

<sup>5</sup>No. 1. DDT (technical) 8 pounds; xylene (industrial) 8 quarts; Triton X-100, ½ pint; water to 100 gallons.

No. 2. DDT (technical) 8 pounds; benzene (industrial) 4½ quarts; Velsicol AR-50, 2 quarts; Triton X-100, ½ pint; water to 100 gallons.

No. 3. DDT (technical) 8 pounds; Sun Solvent 1547, 8 quarts; Triton X-100, ½ pint; water to 100 gallons.

<sup>6</sup>Geigy's Gesarol AK 50.



wettable powder spray began to lose its effectiveness at the top of such an elm after one month. No injury resulted from any of these dormant applications.

All of the above DDT formulations were applied in early August to the same elms at one half the dormant strength, or 1 percent DDT. There was no spray injury, and all the emulsions gave good to poor protection at the top of elms after two months. The wettable powder spray gave poor protection at the tops after one month.

Protection was always better on low branches than at the tops of the elms in both dormant and foliage applications.

3. *With Mist Blowers*<sup>7</sup>.—In dormant applications at least 4 gallons of 12 percent emulsions<sup>8</sup> had to be sprayed at the average elm used in these tests (55 to 70 feet high) to give good protection to the tops for two months. No spray injury resulted on dormant elms from either of the emulsion sprays, but a commercial 12.5 percent DDT-oil solution applied by the modified Buffalo Turbine mist blower caused injury and delayed growth when 4 gallons were applied per elm.

Foliage applications in early August to the same elms in the same concentration and volume resulted in protection almost equal to that of the dormant applications. Two emulsions<sup>9</sup> applied by the Orchardaire mist blower resulted in no foliage injury, but another<sup>10</sup> applied by the Accurate Tool Company mist blower did cause serious foliage injury at this heavy dosage.

**Materials and Methods Which Promise Value in Control of Insect Pests of Ornamental Shrubs, Shade and Forest Trees, and Forest Products.** (W. B. Becker.)

*Insect Control Tests*—(With Hydraulic Sprayers)—DDT wettable powders (2 pounds per 100 gallons) or DDT emulsions (1 quart per 100 gallons) apparently resulted in good prevention of injury by elm leaf miner, *Fenusa ulmi* Sund., and willow leaf beetle, *Plagiodera versicolora* Laich. Rose chafers, *Macrodactylus subspinosus* F., in a flower garden, were considerably reduced by the DDT wettable powders, but some beetle damage to blossoms still occurred, possibly by beetles which alighted on newly opened unsprayed blossoms before they contacted the sprayed foliage. Promising results were obtained against cottoncater lace bugs and the young crawlers of oyster shell scale on lilac. No spray damage was noticed on any of the sprayed plants.

In a preliminary test in early spring, 1 gallon of a 2 percent DDT emulsion spray thoroughly wetted the outside of a 1/3 -cord pile of freshly cut red pine logs, and resulted in a material reduction of the bark and wood boring beetles which later became established in it. Comparison of sprayed and unsprayed log piles the next spring revealed 79 percent reduction of round-headed borer galleries, 86 percent reduction of ambrosia beetle galleries, 100 percent reduction of weevil galleries, and a reduction of more than half the area occupied by bark beetle galleries.

<sup>7</sup> An Accurate Tool Company, a modified Buffalo Turbine, an Orchardaire, and a Stewart-Savage mist blower were used.

<sup>8</sup> Geigy's Gesarol E 25, diluted in water; or DDT (technical) 1 pound; Xylene 2½ pints; Triton X-100, 2 ounces; with water added to make 1 gallon of spray.

<sup>9</sup> DDT (technical) 1 pound; xylene 2½ pints; Triton X-100, 2 ounces; or DDT (technical) 1 pound; Sun Solvent 1547, 1 quart; Triton X-100, 1 ounce; with water added to make 1 gallon of spray, in both cases.

<sup>10</sup> Geigy's Gesarol E 25.

(With Mist Blowers)—In mid-August an Orchardaire mist blower was used to apply a 12 percent DDT emulsion<sup>1</sup> and a 12.5 percent DDT-oil solution<sup>2</sup> to various shade trees to combat insect pests. The quantities of spray applied were close to the small amounts commonly used to control gypsy moth larvae in roadside spraying. Good control of the imported willow leaf beetle, *Plagiodera versicolora* Laich., was obtained along roadsides, but not beyond distances of 75 to 100 feet into the woodland, even with the aid of a slight breeze. Good control of fall webworm, *Hyphantria cunea* Drury, was also obtained along roadsides. Relatively little important spray injury resulted on most plants sprayed lightly in this manner with either spray, except in instances where the blower passed too close to the foliage.

*Spray Injury Tests.*—(With Hydraulic Sprayers)—Dinitro-ortho-cyclohexyl-phenol<sup>3</sup>, used in July at the rate of 1¼ pounds per 100 gallons, injured some broad-leaved deciduous plants, but no needle-bearing plants showed any injury the rest of the season. At the time of application the air temperature was 65° to 78°F., the humidity 70 to 46 percent, and the sky clear and sunny. Tetraethyl pyrophosphate<sup>4</sup>, used at the rate of 1/3 pint per 100 gallons, and parathion<sup>5</sup>, used at the rate of 12 ounces per 100 gallons, caused no foliage injury to any broad-leaved or needle-bearing plants tested in mid-September. At the time of the applications the air temperature was 59° to 64°F. and the humidity 57 to 51 percent, the sky was clear and sunny, and there was a slight breeze.

(With Mist Blowers)—When applied to a number of trees and shrubs somewhat more heavily than would ordinarily be necessary to control leaf-feeding insects, the 12 percent DDT emulsion described above did not cause so much spray damage to foliage as did a commercial DDT-oil solution, except in the case of sugar maple which was severely injured by both.

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## FEED AND FERTILIZER CONTROL SERVICES

John W. Kuzmeski in Charge

The feed, fertilizer and milk testing laws are administered as one service and the operations of each, with the exception of the milk testing law, are reported in annual bulletins.

Under the milk testing law 5,016 pieces of Babcock glassware were calibrated and 233 certificates of proficiency in testing were issued. All milk depots and milk inspection laboratories in the Commonwealth were visited at least once to check apparatus and general conduct of the work.

In addition to the regulatory work the Feed and Fertilizer Control laboratories have examined feeds, fertilizers, and other agricultural materials for citizens of the Commonwealth without charge whenever the results were considered of interest to the general public or to the Control Services.

Considerable work has been done on research projects in cooperation with other departments of the University and Experiment Station. The results of such work are reported by the departments originating the projects.

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<sup>1</sup> DDT (technical) 1 pound; xylene (industrial) 2½ pints; Triton X-100, 2 ounces; with water added to make 1 gallon of spray.

<sup>2</sup> Shell's Mistoil.

<sup>3</sup> Niagara's Hexide 200.

<sup>4</sup> Dow's DN-111.

<sup>5</sup> American Cyanamid's Thiophos 3422.

## DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

**Breeding Snapdragons for Variety Improvement and Disease Resistance.** (Harold E. White, Waltham.) Ten commercial varieties of snapdragons were crossed with Helen Tobin, a variety which was originated at the Waltham Field Station, and the resultant progeny checked for hybrid vigor and flower color. Only two crosses showed any variation in color segregation and then only a few rogues appeared. The other hybrids were uniform as to flower color and an improvement over inbred commercial varieties.

Several white hybrids were inbred and produced good color-pure progeny.

A number of inbred lines and several hybrids were tested under greenhouse conditions in West Chicago, Illinois, with one hybrid reported as outstanding in production and flower color. In December and January this particular rose colored hybrid, No. 11, produced 2.4 flower spikes.

Two strains, P4734 and Y4196, in trials with a grower in Minnesota under field conditions, proved resistant to rust disease. The grower stated that Y4196, a yellow-flowered strain, was so particularly good that he wished to try it another year.

In Lutz, Florida, the Helen Tobin variety has been grown each year since its introduction; this year the growers report that this variety will produce flowers over a longer period than any other one they grow.

A number of hybrids from George J. Ball, Inc., West Chicago, Illinois, were grown at Waltham; those particularly outstanding were Nos. 11 yellow, 12 bronze-red, 19 light pink, 23 rose color, and 34 rose color.

Tetraploid snapdragons tested were very much slower maturing than hybrids and were not so productive under conditions at Waltham.

**Sodium Selenate for Insect Pest Control on Flower Crops.** (Harold E. White, Waltham.) Selenium, in the form of a trade compound known as P-40 (superphosphate impregnated with 2 percent sodium selenate), applied at dosage rates of 3, 4½, and 6 pounds per 100 square feet of bench gave most effective control of red spider on carnations at the 4½ to 6 pound rates of application. The first application was made in August, 1948, and the next one in November, 1948.

Under normal temperature conditions when red spider infestations are light, application of sodium selenate as P-40 shows its effectiveness as a control in about 4 to 6 weeks. However, during the course of this experiment the temperature in the greenhouse was above normal late into the fall because of outside climatic conditions. Consequently the red spider population increased rapidly and the treated plants apparently had not absorbed sufficient selenium from the soil to be toxic to the great numbers of the pest. Following the initial application of P-40 in August, selenium had accumulated in the plant to as high as 100 p.p.m.; and following the second dose in November, selenium reached a concentration of approximately 200 p.p.m., which by January was adequate to keep red spider under control.

Plant analyses for selenium show that 50 p.p.m. is below the minimum for adequate spider control and under normal temperature conditions 100 p.p.m. or more will give satisfactory control.

Sodium selenate applied to the soil in a liquid form at the rate of one-fourth gram per square foot was equally as effective as the higher dosage of P-40. An explanation for this difference is that selenium in the form of P-40 applied to the surface of the soil is released slowly and unevenly by intermittent hose waterings, whereas sodium selenate in solution is carried down more rapidly to the plant roots.



Analyses and lysimeter studies of greenhouse treated soils which were later exposed to outdoor conditions for from 6 to 12 months show that in a mineralized form selenium compounds are readily leached from the soil, whereas forms of selenium intimately associated with organic matter are less readily removed from the soil by heavy leaching.

Soils treated with 6 pounds of P-40 selenate per 100 square feet, cropped for one year to carnations and then leached in the field 4 months, contained 17 p.p.m. of selenium; after 7 months, 4.3 p.p.m.; and at 11 months, 2.9 p.p.m. Samples of weeds grown on this soil contained 13 to 30 p.p.m. of selenium. In lysimeter leaching studies 12 inches of water removed all of the readily leachable selenium and added increments of water up to 60 inches did not appreciably increase the amount of selenium lost from the soil.

Analyses of a number of market garden and field soils showed the presence of 0.50 to 2.5 p.p.m. of selenium. Cabbage plants and weeds growing on these soils showed no detectable selenium in plant tissue tests.

Considerable data on analyses of soils and plant tissue were obtained in this study which will be assembled for a complete publication at a later date. This project was conducted in cooperation with the Department of Agronomy. The chemical analytic work was performed by Robert J. Allen, Jr., as partial requirement for a degree of Master of Science in Agronomy.

**Climatic and Cultural Factors Related to Carnation Diseases.** (Harold E. White, Waltham.) Air and soil temperatures in the greenhouse vitally affect growth and production of a plant crop and also determine progress of plant diseases. Temperatures ranging from 50° to 90°F. have been reported as optimum for the growth of *Fusarium* and *Rhizoctonia* fungi which cause branch rot and wilt diseases of carnations.

Weekly records of air and soil temperatures were kept from July 1948 through April 1949. Highest maximum air temperatures for the greenhouse were recorded in July, August, and September and ranged from 96° to 105°F; corresponding soil temperatures in a raised bench ranged from 65° to 72°. The mean temperatures for the same period were 74° to 76° for the greenhouse and 61° to 70° for the soil.

In this study 4274 plants were used, of which 1297 or 30 percent were lost from disease. Losses were not consistent within the same variety; many of the replicated plots showing losses as high as 40 to 50 percent, whereas in others losses were as low as 1 or 2 percent.

Losses from disease were highest in July, August, and September, the loss of plants following high temperature trends of the greenhouse and soil. Sustained high temperatures of 90°F. or above for long periods seemed to have greater influence on plant losses than extremely high fluctuating temperatures. The critical soil temperature at which plant losses from disease were greatest was 70° or above.

Difference in susceptibility of carnation varieties also has a bearing on diseases. Varieties in which plant losses were extremely high were Salmon Virginia, 82 percent; Olympic Red, 75; Mrs. C. W. Weld, 73; followed by Miller's Yellow, 51 percent; William Sim, 47; Tom Knipe, 36; King Cardinal, 35; Dark Virginia, 32; and Hercules, 30. Losses were very low in Northland and Puritan, being 1 percent or less; while Joan Marie and Virginia Rose showed no losses.

The amount of water applied to carnation plants and methods of application are frequently considered as having an effect on prevalence of stem and branch rot diseases. Plant losses from disease under four methods of applying water to the soil were as follows: copper tubing surface watering, 80 percent; Skinner pipe

system, 34; manual hose method, 81; subirrigation by manual injection, 32; subirrigation by automatic injection, 13; and constant water level, 26.

Age of soils did not appear to be related to disease losses, since soils used were 1 to 5 years old and had grown carnations for 2 or 3 years. All soils were thoroughly sterilized with steam before use.

The data indicate that soil and air temperature, method of watering, and varietal differences are associated with carnation disease losses; but there are also other undetermined factors concerned.

**The Effect of Soluble Salts on Florists' Crops.** (Harold E. White, Waltham.) This experiment was undertaken to determine the levels of soluble salts in carnation soils and to observe the effect of varying concentrations on plant growth. Soil samples were collected monthly over a period of ten months from the greenhouses of twelve commercial growers. Determinations for soluble salts were made by the Solu-Bridge instrument method, using a soil extract with a 1:2 ratio of soil and water respectively. William Sim and Tom Knipe, red-flowered varieties, were the only varieties included in the experiment.

Soluble salt concentrations, as determined by conductivity readings with the Solu-Bridge, ranged from  $50 \times 10^{-5}$  mhos to  $270 \times 10^{-5}$  mhos which correspond approximately to .25 percent and .75 percent respectively of total soluble organic and inorganic salts. There were wide fluctuations between the soils of individual growers as well as variations from month to month. Out of a total of 170 samples tested, 9 percent gave conductivity readings above  $200 \times 10^{-5}$  mhos, 37 percent were between  $100 \times 10^{-5}$  and  $170 \times 10^{-5}$  mhos, and 54 percent were below  $100 \times 10^{-5}$  mhos. A reading of  $200 \times 10^{-5}$  mhos, with a 1:2 soil and water ratio extract is considered the border line above which injury from soluble salts may occur. Soils having a high soluble salt content were high in total nutrient salts, particularly nitrate nitrogen and potassium.

Carnations in the twelve greenhouses showed no differences in growth that could be correlated with the existing soluble salt concentrations. Flower bleaching or burning, which commonly occurs in the spring months, was observed in several of the greenhouses, but this injury was not associated with soluble salts. From the data obtained the conclusion is drawn that carnations are tolerant of a wide range in concentration of soluble salts. However, the critical limits have not yet been determined.

**A New Carnation Disease in Massachusetts.** (Harold E. White, Waltham.) In 1948 a new disease of carnations was discovered by the writer in a greenhouse range near Waltham, and identified as carnation smut, caused by *Ustilago violaceae* (*Urocystis purpurea*). This was the first recorded occurrence of the disease in the United States, although it was recorded in Europe as early as 1926 by Hecke (Fortschr. der Landw. 1, 5, 150-151), and has also been quite destructive to carnations in England. Just how the disease got into Massachusetts is not known. The grower who had the trouble recalls having seen a few plants with the disease in 1947. Wild host plants are species of *Dianthus*, *Cerastium*, *Stellaria*, *Lychnis*, *Saponaria*, and *Silene*.

The fungus is an obligate parasite which invades stamens, the pollen grains being replaced by masses of purplish black spores. Infected plants are dwarfed and axillary shoot growth is stimulated to produce excessive weak laterals. Stem internodes are shortened; buds are short and squatty, tending to split; and ovaries are aborted. Flowers are marred by masses of purplish spores. According to Hecke, infection occurs through spores in the axils of leaves and cut flower stem stubs. Cuttings are infected by the fungus mycelium from mother plants, this being a systematic internal parasite.

The varieties of carnations found infected in Massachusetts were Salmon Virginia, Hercules, Olivette, Miller's Yellow, Northland, William Sim, Tom Knipe, and Sidney Littlefield. Little is known about modes of infection in New England and whether the fungus will winter over on host plants or as spores in the soil.

**Notes on Chrysanthemum Stunt Disease.** (Harold E. White, Waltham.) Stunt disease occurs in indoor plantings of chrysanthemums throughout the State, but severity of the disease is more or less localized. In 1948 observations as to its prevalence were made on twenty-two varieties in a near-by greenhouse. The following varieties showed varying degrees of dwarfing: Yellow Arcadia 25-90 percent; Caroline Yosick and Usonia 90 percent; Little America and Tally-Ho 75 percent; Catherine 25-30 percent; White Arcadia and Golden Jane 10 percent; December Gold, Long Island Beauty, and Yellow Daisy 5 percent. Varieties in the same planting which showed no dwarfing were Firebird, Valencia Apricot, Valencia Yellow, Masterpiece, Sunnyside, Cassandra, Sylvania, Golden Jane, Minong, Red Daisy, and Yellow Dot.

**Stunt Disease of Cyclamen.** (Harold E. White, Waltham.) A local grower experienced a heavy loss of cyclamen plants in October 1948 by a disease which was diagnosed as cyclamen stunt. This is the first record of the disease in New England, although it has been reported in the Midwestern and Western States. The fungus was isolated and found to be *Cladosporium cyclaminis*, which has been previously recorded as the causal organism of stunt disease.

Infected cyclamen plants are very slow growing, with retarded flower and bud development which results in the flowers opening near the crown of the plant and beneath the foliage. The corm and roots of the plant are attacked by the fungus, resulting in the wilting and death of the entire plant.

The source of infection appears to be contaminated soil, but the disease may also be seed-borne.

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## DEPARTMENT OF FOOD TECHNOLOGY

C. R. Fellers in Charge

**Apple Juice.** (W. B. Esselen, Jr., M. Blauer, and C. R. Fellers.) In experimental lots of blended apple juice put up during the past season it was found that the use of apple "thinnings" and early apples for blending with mature McIntosh apples was not too satisfactory so far as the quality of the finished juice was concerned. Although the early apples and "thinnings" were higher in tannin and acid than the mature McIntosh apples they were low in solids and exerted a dilution effect on the blended juice. As has been previously observed, the blending of approximately 5 percent of crab apples with McIntosh apples was effective in improving the quality of the finished product.

**Processing Methods for Home Canned Fruits.** (W. B. Esselen, Jr., and N. Glazier.) Several varieties each of blueberries, cherries, pears, peaches, and plums were canned by recommended "cold pack" and "hot pack" methods in order to compare the effect of these two canning procedures on the quality of the product. The ultimate quality of the products was evaluated by a taste acceptance panel on a basis of flavor, texture, and color. "Cold pack" methods appeared to be preferable to "hot pack" methods for pears, peaches, and plums, while the reverse was true for blueberries. Cold and hot packed cherries were considered to be equally satisfactory.



**Heat Resistance of Home Canning Spoilage Bacteria in Soils Given Different Fertilizer Treatments.** (N. W. Desrosier and W. B. Esselen, Jr.) During 1948-49, putrefactive anaerobes were isolated from test plot soils, made available by the Agronomy Department, as follows: a. unfertilized soil, lime added; b. same as "a" with potassium added; c. same as "a" with phosphorus added; d. same as "a" with nitrogen added; e. complete NPK fertilized soil with lime added. The numbers of putrefactive anaerobes isolated from these soils were less than 100 per gram. The heat resistance of the spores isolated and cultivated was in all instances very low, less than one and a half minutes at 250°F. The phosphorus-treated soil ("c") isolates were of somewhat greater heat resistance than the isolates from the other soils. In general, the type of fertilizer employed had little influence on the heat resistance of the organism studied.

The apparent success of home canning of vegetables by the boiling-water method appears to be due to the fact that only small numbers of anaerobic spore-forming bacteria of relatively low heat resistance are present. However, similar organisms of much greater heat resistance are encountered from time to time, and pressure processing of these foods must be used to insure success in preventing spoilage and provide a safe product for consumption.

**Influence of Food Ingredients on the Heat Resistance of Spores of Putrefactive Anaerobe No. 3679.** (N. W. Desrosier and W. B. Esselen, Jr.) The ingredients of a molasses sauce and a tomato sauce used in the preparation of pork and beans were investigated. Individually, the ingredients of the molasses sauce had little effect on the heat resistance of the test spores of Putrefactive Anaerobe No. 3679 (*Clostridium sporogenes* sp.); but when these ingredients were all present, a decided increase in the resistance was observed. Evidently the individual effects were not of sufficient amplitude to be observed, or the methods employed were not sufficiently sensitive. The ingredients of the tomato sauce had comparably greater influence. The addition of vinegar and tomato juice resulted in about the same increase in hydrogen ion concentration. However, the tomato juice decreased the heat resistance more than the vinegar. The toxicity of the hydrogen ion itself does have considerable influence, but there is apparently some substance present in the juice other than the acidity which exhibits a bactericidal action against the spores. Salt in 2 percent solution decreased the resistance somewhat, and a 5 percent sugar solution increased the resistance of the spores.

**Processing Studies on Home-Canned, Low-Acid Foods.** (Cooperative Project with Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture.) (W. B. Esselen, Jr., N. W. Desrosier, D. W. Anderson, Jr., and G. Marcotte.) Pressure processing studies have been made with home canned hominy, potatoes (whole and diced), and pork and beans with a tomato and molasses sauce. These products have not been studied before.

**A. The Degree of Contamination of Foods and Its Effect on Home-Canning Process Times.**—It has often been argued that the processing requirements as described for commercially canned products are more severe than those required for similar home-canned foods. The assumption has been that in home canning a lower bacterial load is encountered in the raw products, equipment, etc. In view of this assumption, tests were set up to obtain indicative data on the effect of the degree of contamination or spore concentration on the processing times required for hominy, pork and beans, potatoes, and sweet corn. It was shown that the lethal value of home-canning process times should be at least equivalent to those used in commercial practice.

B. *Thermal Death Time Studies*.—The thermal death time characteristics of a concentration of 10,000 spores of Putrefactive Anaerobe No. 3679 per milliliter were determined in hominy, bean, and potato extracts, and were found to be 7.2, 8.2 and 7.4 minutes at 250°F., respectively. It would appear that home-canning process times to be adequate must provide this degree of sterilization for each of the above products.

C. *Heat Penetration Studies*.—The rate of heat penetration into pint and quart glass containers, and No. 2 and 2½ cans, for each of the above products was investigated. The rate of heat penetration and the thermal resistance of the test organism were correlated, and process times were derived.

D. *Inoculated Packs*.—The theoretical process times were checked by means of experimentally prepared packs, and the process times were found to be in good agreement with the above values.

**An Inhibitory Substance Present in Green Beans and the Growth of Putrefactive Anaerobe No. 3679.** (N. W. Desrosier and W. B. Esselen, Jr.) Considerable difficulty has been encountered in the past in growing Putrefactive Anaerobe No. 3679 in a green-bean medium. Occasionally growth is evidenced, but in general the organism does not grow well in this medium. Attempts to recover the organism from an inoculated green-bean medium failed. The addition of starch to the medium had no effect. The isolation of the inhibitory substances has not been completed, but the presence of quercetin in the beans offers a possible explanation. It has been reported by others that the presence of this compound inhibits the production of toxin by *Clostridium botulinum* in asparagus. However, some outbreaks of botulism have been traced to asparagus. There may be varietal differences which offer a possible explanation as to the growth and non-growth of the test organism in green beans.

**Studies on the Mechanism of Heat Transfer in Glass Containers During Thermal Processing.** (W. B. Esselen, Jr., and I. S. Fagerson.) The object of this investigation has been to study the factors influencing heat transfer rates and temperature distribution in commercial glass containers, the mechanisms of "broken-curve" heating, the significance of radiation as a mechanism in the cooling of glass containers, and the effect of container size on heating rates in glass containers.

*Time-Temperature Distribution Patterns in Commercial Jars*.—Data have been obtained for commercial 303 size jars at initial temperatures of 140° and 180°F. with 1 percent bentonite suspensions. Temperature distribution patterns were obtained by means of thermocouples located in different parts of the container.

It was noted that, in general, the rate of heating tended to be somewhat greater near the upper part of the container, probably because the rate of heat transfer was greater through the metal cap of the jar and the warmer, rising convection currents began to converge in this area.

While the slowest rate of heating was found to be in the vicinity of the generally acknowledged "cold zone", i. e., on the vertical axis and approximately three quarters of an inch from the bottom of the jar, it was often noted that comparably slow heating rates were found at a point one inch from the wall and two inches from the bottom of the jar. This observation appeared worthy of further investigation in the light of the determination of the cold point or cold zone for process-time calculations. Accordingly, the distribution and direction of convection currents were studied by introducing a dye (methylene blue) into a jar of water

and taking motion pictures of the resulting currents as the jar was heated in a constant-temperature water bath. Under the experimental conditions (initial temperature of 50°F. and water bath at 145°F.), the convection currents in 303 size jars traveled rapidly from the bottom upward along the inner surface of the container and formed a slowly descending central column within about 15 seconds after the beginning of the heating period. From 3 to 5 minutes later, the descending central column reached the bottom of the jar. During this time, currents had started from the center of the bottom of the jar and traveled upward to about  $1\frac{1}{2}$  inches from the bottom, the height attained progressively decreasing with time until after 5 minutes the currents were only traveling to about  $\frac{3}{4}$  inch from the bottom. The velocity as well as the height attained by the rising currents next to the wall of the jar progressively decreased with time so that at the end of about 20 minutes they rose only to within an inch of the top before returning and at the end of about 27 minutes rose only to about one-half the jar height. At this time the temperature at a point  $\frac{3}{4}$  inch from the bottom of the jar on the vertical axis was about 8°F. below the water bath temperature.

Similar observations made on a series of 10, 20, 30, 40, and 50 percent sucrose solutions showed the same type of distribution and direction except that the velocities of the currents appeared to be somewhat slower. From the data obtained it appears that the contents of the jars are well agitated due to natural convection, especially at the beginning of the heating period when the temperature differentials are the greatest.

*Mechanisms of "Broken-Curve" Heating.*—Heat penetration measurements were made on 10, 20, 30, 40, and 50 percent sucrose solutions in 303 size jars as a means of studying the effect of viscosity in convection heat transfer. It was noted that the 10 and 20 percent solutions exhibited simple heating curves, but the remainder all showed broken-curve heating. The data indicate a slightly slower rate of heating after the break in the curve, but not a change from convection to conduction. The above measurements were made using methylene blue so that convection currents could be followed at the same time. It was observed that the break in the curve always occurred after the convection currents had considerably decreased in velocity. This work is being continued.

**Influence of Food Ingredients on the Thermal Resistance of *Bacillus Thermoacidurans*.** (E. E. Anderson and W. B. Esselen, Jr.) The role of various concentrations of sugars, salt, acids, spices, and sodium benzoate, in affecting the thermal resistance of *Bacillus thermoacidurans* spores in tomato juice, was determined at three temperatures, 220°, 212°, and 204°F. From the data obtained from the rate of destruction curves, thermal death time curves were constructed. A study of these curves showed the influence of the particular food ingredient under study on the "F" and "z" values of the test organism.

Of the above-named ingredients, sucrose and dextrose, in concentrations ranging from 10 to 50 percent, were the only food materials which decidedly increased the thermal resistance of a standard spore inoculum of *B. thermoacidurans*. With both of the sugars, each increase in the concentration of the sugar increased the resistance over that in plain tomato juice. The maximum heat resistance was displayed by the 50 percent sugar solutions, which at 204°F. required from two to two and one-half times as long as plain tomato juice to destroy the test inoculum.

The addition of common salt (sodium chloride) to tomato juice, in concentrations ranging from 1 to 8 percent, caused a definite increase in the rate of destruction and therefore decrease in the destruction time of *B. thermoacidurans*.



A search of the literature revealed conflicting reports as to whether salt exhibited a protective or a lethal effect on microorganisms. Consequently, the lethal effects of increasing salt concentrations observed in the present investigation, were attributed to the increase in the hydrogen-ion concentration of the substrate. The incorporation of 2 percent salt, a concentration commonly used in brines, lowered destruction times approximately 20 percent.

The addition of citric, acetic, and lactic acids to tomato juice in concentrations of 0.5, 1.0, and 2.0 percent, proved to be a very effective means of reducing the heat resistance of *B. thermoacidurans*. Based on the percentages used, the efficiency of the acids in lowering the destruction time of the test organism was lactic, citric, and acetic; while based on the hydrogen-ion concentration, the order was: acetic, lactic, and citric.

Inasmuch as certain spices are known to exert bacteriostatic and even bactericidal action against microorganisms at room temperatures, the study of the effect of certain spices at temperatures common to the processing of acid foods was carried out. Oil of clove in concentrations of 0.01 and 0.1 percent and black pepper in concentrations of 0.1 and 1.0 percent in tomato juice resulted in increased rates of destruction and thereby decreased destruction times.

Neither sodium benzoate in a concentration of 0.1 percent nor ascorbic acid at a level of 200 mg. of ascorbic acid per pint of tomato juice caused any appreciable change in destruction times from those required by plain tomato juice.

**Effect of Allylisothiocyanate (mustard oil) and Related Compounds on the Process Requirements of Acid Foods.** (W. B. Esselen, Jr., O. Kosker, E. E. Anderson, and C. R. Fellers.) This investigation has been continued and considerable data on thermal death rate and thermal death time have been obtained to demonstrate the effect of allylisothiocyanate (mustard oil) and related compounds on the spoilage organisms encountered in acid foods. Inoculated packs of apple, grape, and tomato juices were also made to check on the validity of the data obtained. The results may be summarized as follows:

1. The thermal death times of *Aspergillus niger* in acid, sugar, and buffer solutions at different pH values were reduced approximately 50 percent at each temperature used, when 10 p.p.m. of mustard oil was added to the heating medium.
2. A reduction of approximately 50 percent in heat resistance was obtained in the thermal death time of *Saccharomyces ellipsoideus* when 10 p.p.m. of mustard oil was added to the heating medium.
3. The effect of mustard oil on the thermal death time of *Bacillus thermoacidurans* was not as pronounced as it was on mold and yeast. It would appear that this organism is not sensitive to this compound.
4. Oil of onion and oil of garlic in concentrations of 20 p.p.m. had little or no effect on the thermal death time of *B. thermoacidurans*.
5. The results obtained with inoculated packs of apple juice, using *Asp. niger* were in good agreement with the calculated process time based on the data obtained for heat penetration and thermal death time.
6. With the test organisms (mold and yeast) used, it would appear that the process times for apple and grape juices could be reduced 50 percent by the addition of 10 p.p.m. of mustard oil.
7. A concentration of 20 p.p.m. of mustard oil did not reduce the process requirements for tomato juice for *B. thermoacidurans* when determined by inoculated packs.

**Studies on the Peroxidase of Canned Acid Food Products.** (W. B. Esselen, Jr., E. A. Nebesky, and A. M. Kaplan.) A study has been made of some of the

factors affecting the thermal destruction curve of peroxidase. Calculations of the process time necessary to inactivate the peroxidase for a solid food must be based on the rate of heat penetration into the food itself. When substances that may influence enzyme inactivation such as sugar, salt, or vinegar are added to solid food products, the extent of their penetration into the food during preparation and processing must be considered. Observations were also made of experimental packs to evaluate the calculated process times. Studies were also begun to determine the effect of concentration of peroxidase on the thermal inactivation of the enzyme. A successful procedure has been developed in which a concentrated peroxidase extract could be obtained from apples.

A. *Processing Conditions of Time and Temperature.*—A study was made to determine the processing conditions of time and temperature necessary to destroy the peroxidase of canned solid food products such as whole fresh and salt pickles, peach and pear halves, apple slices, and one liquid product, apple cider.

Enzyme assays for peroxidase were carried out using a number of different substrates such as hydroquinone, guaiacol, pyrogallol, ortho-phenylenediamine, benzidine, and catechol.

In determining enzyme activity using the above-mentioned substrates with thermal destruction time studies and with processed food packs the peroxidase activity differed with the substrate. For example, studies with apple slices and apple cider using guaiacol, pyrogallol, or catechol as the substrate produced results which were identical and showed that these enzymes were of high thermal resistance in comparison with hydroquinone, benzidine, and ortho-phenylenediamine substrates. The first group of substrates showed peroxidase to be destroyed in between 20 and 25 minutes at 160°F., and between 3 and 4 minutes at 190°F.; while the second group showed peroxidase to be destroyed in between 10 and 15 minutes at 160° and between 2 and 3 minutes at 190°. Similar variations appeared among the various substrates studied with the other products concerned in this investigation. Guaiacol was considered to be the most suitable substrate to use for the enzyme assays because the thermal resistance of guaiacol peroxidase was as high as or higher than that of the other substrates mentioned, with the particular foods under study. The guaiacol substrate also produced a much more distinct difference in color which could be very easily recognized and thereby tended towards greater accuracy in the performance of the enzyme assay.

Heat penetration data were obtained for each of the different types of products used, in order to determine the accuracy of the thermal destruction data for peroxidase when applied to the derivation of processing time and temperature necessary to inactivate it. From these data calculated process times for the respective foods were determined.

Calculated process times for the various products studied were evaluated through the processing of experimental packs and showed close agreement with observed process times. Thus the possibility of closely calculating the processing conditions for the destruction of peroxidase in solid products, such as whole pickles, peach and pear halves, and apple slices, appears to be very good.

Investigations were also made to determine the amount of sugar penetration into fruit products and vinegar penetration into pickle products during preparation and processing. It was found that the addition of sugar increased the resistance of the apple and pear peroxidase to inactivation by heat. The addition of a 2.5 or 5.0 percent vinegar solution markedly decreased the resistance of the pickle peroxidase to inactivation by heat.

B. *Concentration of Peroxidase.*—Studies have also been initiated to determine the effect of concentration of peroxidase on thermal inactivation of the en-

zyme. This necessitated the development of a suitable technique for the purification and concentration of the peroxidase from the food product. It was found that if the concentration of peroxidase was increased its resistance to inactivation by heat was also increased.

**Influence of Venting Characteristics of Home Canning Jar Closures on Ascorbic Acid Retention in Home-Canned Fruits.** (W. B. Esselen, Jr., L. F. Ruder, and A. M. Kaplan.) The venting characteristics of home canning jar closures were found to have a direct relationship to the retention of ascorbic acid in products canned in such containers. That is, closures with a low venting pressure, such as those that are partially sealed, permit more headspace air to escape from the jar during processing and a greater retention of ascorbic acid in the canned product is realized. Canned apple sauce, pears, and peaches as well as ascorbic acid in buffer solutions at pH 3.5, 4.0, and 4.5 were used as the experimental media in these investigations. These findings confirm previous observations made several years ago with home-canned tomato juice.

**Changes in Volatile Reducing Substances as a Measure of Deterioration in Foods.** (W. B. Esselen, Jr., T. O'Grady, and E. E. Anderson.) The "Stinkometer", an apparatus designed by workers at the Hooper Foundation in California to measure the volatile reducing substances in fish, has been used for measuring the deterioration of other food products during storage. It appears to be of value as a means of following changes in the volatile reducing substances in packaged coffee during storage. Changes in these compounds could be correlated with the staling and development of rancidity in coffee. The method was also useful in following the development of spoilage in fresh beef during storage at different temperatures. However, it was not satisfactory for studying the deterioration of vegetable oils such as corn, cotton, and peanut oils.

**Home Freezing.** (W. B. Esselen, Jr., E. E. Anderson, N. W. Desrosier, N. Glazier, and C. R. Fellers.) During the past season 13 varieties of strawberries, 10 of blueberries, 12 of cherries, 5 of currants, 38 of peaches, 10 of pears, 20 of plums, and 28 of raspberries, provided through the cooperation of the Department of Pomology, were tested for their suitability for home freezing. The data on varieties of fruits for freezing obtained during the past four years were used in preparing a revised list of recommended varieties of fruits for freezing in Massachusetts, which is included in the revised edition of Bulletin No. 437, "Home Freezing in Massachusetts."

Further work is in progress on the use of different types of glass jars for home freezing. No evidence has been found, either in practice or from a review of the technological aspects of glass, to confirm the opinion expressed in many home-freezing bulletins, that glass is more brittle when cold.

The blueberries frozen during the past season showed a tendency to develop excessively tough skins. This condition was not encountered in previous years.

**Home Preservation of Herbs.** (W. B. Esselen, Jr.). Rapid drying at temperatures below 130°-120°F., or slow drying in an attic or in the shade were found to yield the best quality of dried herbs as measured by their volatile oil content. Dehydration at temperatures above 130°F. resulted in an excess loss of volatile oils and flavor. Blanching in steam or boiling water caused a loss of over 90 percent of the volatile oil content of herbs.

**Enzyme Systems of the Apple.** (W. B. Esselen, Jr., R. R. Reddi, and C. R. Fellers.) Some of the enzyme systems of apples have been investigated in order to obtain information which might contribute to a better understanding of the



cause and control of the discoloration which occurs in fresh and frozen sliced apples. Pectinase, protease, and esterase activity could not be demonstrated in fresh apple tissue. Studies on the enzymatic oxidation of ascorbic acid by apples showed that the presence of oxygen is essential to the reaction. The peroxidase activity of apple extracts was measured with different substrates; namely, guaiacol, ortho-phenylenediamine and pyrogallol. The method using ortho-phenylenediamine as the substrate proved to be the most sensitive for colorimetric measurements. Heat inactivation characteristics of apple peroxidase showed that whereas with partial inactivation some reactivation occurred after 20 hours, complete inactivation was not followed by the reappearance of activity during that period.

**Factors Influencing the Mold Content of Cranberries.** (W. B. Esselen, Jr., and C. R. Fellers.) Samples of so-called "sunburned" or "scalded" cranberries were found to be free of mold filaments. Samples of cranberries were obtained from bogs which had traditionally yielded fruit of good and poor keeping quality, respectively. No correlation was found between the mold content of selected "sound" samples and the general keeping quality of the fruit. Random samples of cranberries grown on different bogs and taken from storage in October showed few or no mold filaments in the sound fruit. Similar samples collected in November showed a general increase in the mold content of sound cranberries and occasional samples had a relatively high mold content. Samples of "sound" cranberries stored at 35° and 45°F., which were taken from storage the latter part of March, showed a low content of mold filaments and there was no correlation between their mold content and the temperature at which they were stored.

**Methods of Color Measurement for Controlling Color of Cranberry Cocktail and Sauce.** (W. B. Esselen, Jr.) The cranberry processing industry is frequently confronted with the problem of blending lots of cranberries of different intensities of color in order to maintain a uniform color in cranberry cocktail and sauce. A simple colorimetric method has been worked out which appears to be adaptable for canning-plant use in blending cranberries of different colors in the correct proportions to maintain a uniform color in the finished product. The Luximeter, an instrument made by the General Electric Company, was used in these tests and appears to be satisfactory for the purpose.

**Utilization of Massachusetts Fruits for Home Wine Making.** (W. B. Esselen, Jr., M. Kaplan, N. W. Desrosier, and E. E. Anderson.) During the past season experimental lots of wine were made from apples, cranberries, rum cherries, elderberries, grapes, pears, peaches, plums, and raspberries. Such variables as the use of pure yeast cultures, natural yeast, temperature of fermentation, and addition of sulfur dioxide were considered. The use of pure wine yeast inocula, addition of 100 p.p.m. of sulfur dioxide, and fermentation at a temperature of approximately 70°F. were effective in preventing the development of an undesirably high volatile acid content in homemade fruit wine. As most of the above fruits are relatively low in sugar content, additional sugar may be added to the fruit musts to raise their sugar content to 24 to 28 percent at the start. An additional 4 to 5 percent of sugar may be added during the course of the fermentation. Wines prepared by these procedures had a final alcohol content of 13 to 15 percent by volume. The finished wines were excessively acid in some cases. However, the addition of 2 to 8 percent sugar to the wine, depending upon its acidity, at the time of bottling and pasteurizing resulted in pleasing and palatable wines.

Elderberries and rum cherries were unsatisfactory when made into wine without being diluted with equal parts of water prior to fermentation. Difficulty was encountered in obtaining a complete fermentation in making cranberry wine.

**Moisture Equilibrium Studies.** (A. S. Levine, I. S. Fagerson, and E. A. Nebesky.) The effect of temperature and humidity is of considerable importance in the storage and "shelf-life" of packaged foods, particularly those with an original low moisture content. The relationship between the moisture content of a food-stuff and the equilibrium relative humidity when presented graphically is referred to as a moisture equilibrium curve or a sorption isotherm. Present methods of determining these curves are fairly complex and relatively little has been done with food products. A simplified procedure has been developed and is being evaluated against standard procedures. In addition moisture equilibrium studies are being conducted on various food products.

**Preservation of Sturgeon Roe (Caviar).** (A. S. Levine, C. R. Fellers, and A. Patron.) A detailed pasteurization procedure was developed for preserving Russian caviar in hermetically sealed glass containers. The maximum processing temperature at which quality could be maintained was found to be 155°F. The preserved product retained original quality as indicated by little or no change in color, texture, and flavor. The heat treatment was adequate to prevent spoilage through microbial action.

When preserved Russian caviar is held in storage for periods longer than a year at temperatures above ordinary room temperature, whitish irregular spots develop which resemble mold growth and detract from the product's appearance. Investigation showed that these spots consisted of crystalline tyrosine. It is recommended that pasteurized caviar be stored at cool temperatures to prevent this unsightly condition.

**Vitamin D Bioassay Research.** (L. R. Parkinson and C. R. Fellers.) There is still no adequate chemical method for the determination of vitamin D in many foods, particularly milk. Several of the proposed methods have been checked against the standard rat bioassay.

About 100 samples of vitamin D milk were examined this past year. Six samples were found to contain less vitamin D than was guaranteed on the cap of the bottle.

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## DEPARTMENT OF FORESTRY AND WILDLIFE MANAGEMENT

R. P. Holdsworth and R. E. Trippensee in Charge

**Height-Strength Relationships on Plantation-Grown Red Pine.** (Alton B. Cole and J. H. Rich.) This study is a continuation of the work done by James M. Ring and J. H. Rich during 1947-48 on the effects of growth rate and varying wood densities of plantation-grown red pine on its properties and uses. Test specimens from 12 sample poles collected by Mr. Ring have been used, and samples taken from three distinct elevations in the stem have been subjected to breaking tests. Preliminary data evidence a pronounced reduction in specific gravity and percentage of summer wood with increase in height from the stump, which may indicate a reduction in strength. Numerous inquiries relative to the uses of red pine for tobacco posts, fence posts, and other products give importance to the study, which may result in a justification of increase in size specifications to provide satisfactory markets for this material. This study was supported by the American Creosoting Company.

**The Effects of Seedbed Treatment on the Natural Establishment of Eastern White Pine.** (Arnold D. Rhodes.) In August 1947, sixteen one-fortieth acre plots were established under an even-aged stand of eastern white pine approxi-

mately fifty years old, which because of poor form and quality was about to be clear-cut. Four conditions of seedbed were created as follows, each replicated three times: removal of the forest floor by burning, removal by raking, scarification of the floor by turning a tractor on one tread, and retention of the floor undisturbed (control).

A heavy seed crop borne that fall deposited seed at the approximate rate of 400,000 seeds per acre as determined by eight seed traps. The actual number of seeds which fell upon any one plot is not known. During the ensuing winter, the pine was harvested and all woody vegetation except the smallest shrubs was cut back to the ground. All cut material and logging slash were removed from the plots. Germination of seed and survival of seedlings were recorded at weekly intervals during the spring and early summer of 1948, and at longer intervals later. Preliminary results after the first year of observations are as follows:

1. Arrangement of treatments in decreasing order with respect to—

Germination: scarification, control, burning, raking.

Percentage survival: raking, burning, scarification, control.

Seedlings alive at end of growing season: scarification, raking, burning, control.

2. Germination was adequate by any form of treatment and does not appear to pose a problem. Conditions influencing survival are the critical factors.

3. Survival was favored by the development of herbaceous growth which protected seedlings against high temperatures. Such development was most rapid on raked plots, least on control plots, and intermediate on the others.

4. First-year survival was adequate under all forms of treatment except retention of the forest floor (control). Undisturbed litter without some form of shade such as brush or neighboring trees is unlikely to produce a satisfactory crop of seedlings.

The project is being continued to determine the effect of competition upon seedling survival—competition from both herbaceous growth and woody plants which are becoming established rapidly.

**Incidence and Control of Damage to the Northern White Pine by the White Pine Weevil, *Pissodes Strobi*.** (R. P. Holdsworth.) Since 1920 an annual coverage of Mt. Toby forest has been made for the removal of weevilled growth tips. An accurate count has been made and a graph plotted. Up to 1948 the trend of the curve was down, reaching practically zero in 1946. In 1948 the incidence of the weevil greatly increased, but did not reach the peak of 1920. The weevilled tips are collected and placed in wire cages which retain the weevil but allow the escape of possible parasites. Sufficient data have now been collected to support an attempt to correlate weevil incidence with weather and certain forest factors. Arising from this study has been the development of techniques making possible the substitution of an undamaged lateral for the weevil-destroyed leader, thus preventing forking and saving the forest value of the tree treated. The study is being continued and an attempt will be made to determine the spring emergence date of weevils which over-winter in the forest floor.

**Factors Affecting Damage to Communication Cables by Squirrels and the Possibility of Developing Means of Preventing Such Damage.** (Wesley R. Jones and R. E. Trippensee.) This is a continuation of the study of gray squirrel damage to lead-covered telephone cables, carried out in the previous year by Paul A. White. Work this year has been devoted to the testing of various styles of telephone cables with five squirrels, two males and three females, all on a complete diet. The cables include three sizes of a lead-covered cable, a lead cable



covered with glass fibre tape, and a polythylene-covered cable. Only one squirrel, a young female, did any gnawing damage to cables, this to a  $\frac{1}{2}$ -inch lead-covered cable. The results obtained indicate that squirrels on adequate diet do little damage to lead-covered cables, and tend to confirm our previous conclusions that cable gnawing results from inadequate diet, probably lacking in calcium.

The study is being continued next year with fifteen squirrels, and an attempt will be made to so adjust their diet that gnawing damage can be caused or stopped at will. This project is supported by the Bell Telephone Laboratories of New York.

**Biological Conditions Relating to Reproduction, Development, and Growth of the Pheasant.** (Clark Corliss and Edward E. Pullen.) The embryology of the Mongolian pheasant was studied by Corliss, who is preparing his findings in the form of a thesis. His work indicates the possibility of producing and incubating pheasant eggs during the winter months under increased lighting. The forcing of pheasants by the use of lights is now being practiced on game farms. This study of pheasant embryology will help to explain some of the unknown aspects of pheasant ecology.

The occurrence and distribution of Argentaffin cells in the digestive tract of pheasants was studied by Pullen. The study showed the presence but unequal distribution of these cells in the pheasant. Argentaffin cells, the presence of which in the pheasant had not been demonstrated prior to this study, have no known function.

**Ecology and Economic Importance of the Bobcat.** (E. M. Pollack.) This study was started in September 1942 for the purpose of evaluating the economic status of the bobcat in the Northeast by analyses of food consumed, and of contributing additional knowledge on the ecology of this fur bearer.

Analyses of 224 stomachs and several hundred scats has yielded the most complete data available on food habits. Rabbits have proved the most important food item. Studies on 172 carcasses have given important information on size, age, sex ratio, and reproductive behavior. Original observations on the habits of the bobcat in its natural environment have been recorded by intensive field work.

Cooperators: U. S. Fish and Wildlife Service; Massachusetts Division of Fisheries and Game; The Wildlife Institute; University of Massachusetts.

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## DEPARTMENT OF HOME ECONOMICS NUTRITION

Anne W. Wertz in Charge

**The Effect of Alcohol Consumption on the Utilization of Thiamine.** (P. Shaw and A. W. Wertz.) Reports in the literature and preliminary experiments in this laboratory indicated that alcohol when fed to albino rats exerted a sparing action on the use of thiamine by the animal. This subject has been further investigated in the past year. Results of this further work warrant the conclusion that alcohol *per se* does not affect the utilization or storage of thiamine in the body. It also appears that the metabolism of the amount of alcohol fed did not require an appreciable amount of thiamine.

**The Nutritional Status of Pregnant Women.** (A. W. Wertz, M. E. Lojkin, P. Shaw, G. C. Hagan, E. Morse, and C. Greenfield.) This project is being carried out as part of the Northeast Regional Cooperative Project on Nutritional Status as previously reported (Mass. Agr. Exp. Sta. Bul. 449 p. 58, 1948), and

with the cooperation of Dr. Eugene M. Holden of Amherst. Twenty-nine pregnant women have cooperated in the experiment to date. Preliminary data on the different phases of the study indicate some interesting observations.

**Dietary Studies:** Thirty-nine 7-day food records kept by the pregnant women under study have been obtained and checked by individual nutrients for their adequacy in respect to the Recommended Daily Allowances of the National Research Council. It was found that a very small percentage of the dietaries met the recommended daily allowances. None met the recommended daily allowance for thiamine, 2.5 percent for riboflavin, 2.5 percent for niacin, 64 percent for Vitamin A, 33 percent for ascorbic acid, 10 percent for calories, 5 percent for protein, 2.5 percent for calcium, and 5 percent for iron. It would seem from this information that the nutrient intake of these expectant mothers is sub-optimum according to our present-day standards.

**Blood Studies:** Blood samples are obtained from the pregnant women at three different times during the experiment and are analyzed for certain nutrients. Those samples obtained in the first half of pregnancy show that the largest number of the values for serum Vitamin A, serum protein, and hemoglobin fell within the range classified as fair. The largest number of values for carotene and ascorbic acid fell in the range classified as good. In all cases studied so far, the hemoglobin and serum protein values have increased considerably by the third month post partum.

No interpretation of the data obtained on the *urine studies* and the *physical examinations* has as yet been made. After the project is complete, correlations will be attempted between the data obtained in the four phases of study.

**A Study of the Methods for Obtaining Dietary Histories.** (G. C. Hagan, A. W. Wertz, P. Shaw, and C. Greenfield.) What technique to use is one of the major problems encountered in the planning of any study that necessitates obtaining an accurate picture of an individual's dietary. Many techniques are used by various workers in the field with very little scientific evidence to support the validity of any of them. The methods used involve different interview techniques, recall, and the keeping of a record of actual food eaten for varying lengths of time.

In this present study results obtained by some of these different methods have been compared, with the hope that the most suitable method might be determined. The data obtained by use of the dietary interview technique do not agree well with the data obtained from the records of the actual food eaten for a 7-day period. Indications are that the homemaker tends to overestimate her food consumption on the interview. Analysis of the data obtained from the food records show that a 5- or 7-day food record gives a much better picture of an individual's dietary history than one kept for a shorter time.

**Calculated vs. Analyzed Food Values.** (M. E. Lojkin, P. Shaw, A. W. Wertz, G. C. Hagan, C. E. Greenfield, and E. Morse.) In order to obtain some information on the validity of the food composition tables, used in the study on nutritional status for the calculation of dietary nutrients in the diets of the subjects, chemical analysis of 21 individual weighed 24-hour food intakes was made for certain nutrients. The values obtained by analysis were compared with the values calculated from the food composition tables. Although there is great variation in the individual food samples between analyzed and calculated values, the average values show good agreement for several nutrients studied. In all cases except two, the average analyzed values were higher than the average calculated values. Analyzed values for the fat and ascorbic acid were lower than

the calculated values by 10 and 17 percent respectively. Analyzed values for protein, calcium, phosphorus, thiamine, riboflavin, and niacin were higher than the calculated values by 3, 3, 5, 11, 31, and 15 percent respectively.

**Rodent Control Research.** (Leonard R. Parkinson.) During the past year experiments have been in progress to determine if possible the reason or reasons for the variation in toxicity ratings of identical samples of red squill. Several of these experiments are still in progress, but the data obtained to date seem to indicate that there is as much variation in susceptibility between the strains of test rats as there is within a single strain. The nutritional background was thought to be a factor. The several strains of test rats used received the same basal ration from birth and still this variation in susceptibility persisted. It now seems that a toxicity rating using the standard reference sample must be established for each strain of test rats in use. Then on subsequent testing one only needs to specify the strain of rats used when giving a toxicity rating.

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## DEPARTMENT OF HORTICULTURE

Clark L. Thayer in Charge

**Study of Herbaceous Perennial Material.** (C. J. Gilgut and Paul Bobula, Waltham.) The test garden of perennials was maintained in presentable condition throughout the season and was visited by many people. It is the only one of its kind in New England, and if value of a project may be judged by the number who visit it and show interest in it, then the test garden is one of the most worth while. The numerous requests received indicate that the public is in need of the information on culture, ornamental value, uses, propagation, and sources of ornamental perennials which these test gardens furnish.

At present the garden contains more than 2200 of the better herbaceous perennials. Thirty-five did not survive the winter, although it was mild; seventeen were discarded because they were not true to name, were no longer available commercially, or had been superseded by better and more desirable varieties; and eighteen new varieties, not previously grown in the garden, were added during the season.

The phlox collection now contains many of the better varieties but is not complete and many more are needed for study.

The collection of *hemerocallis* is now in its second year and, although there has been some bloom, it will not be ready for evaluation until the plants are well established.

The aster collection, once the most extensive in the country, became a war casualty. It is now being rebuilt and already contains 36 of the better varieties in commerce. More will be added to make it again one of the best collections in the East.

Foliar nematode, one of the most serious pests of outdoor chrysanthemums, was not satisfactorily controlled by sodium selenate used as a soil drench or mixed with soil at planting time. Varying dosages and times of application were investigated. Nor did weekly spraying with DDT wettable powder, or dusting with DDT control this pest.

**Control of Weeds in the Nursery by Chemical Sprays.** (C. J. Gilgut, Waltham.) From May to November, Sovasol No. 5 was applied manually to weeds in the nursery, with a 3-gallon pressure tank sprayer equipped with a special nozzle which produces a flat fan-shaped spray. Manual application is desirable since



the oil is not sufficiently selective for indiscriminate application, and many nursery plants are highly susceptible to injury. A flat fan-shaped spray facilitates wetting the weeds without subjecting the nursery plants to injurious amounts of the weed killer.

Observations on tolerance to the oil were made on narrow-leaf evergreens, broadleaf evergreens, deciduous trees and shrubs, and herbaceous perennials. The narrow-leaf evergreens were represented by 7 species and varieties of Juniper; 6 of *Picea*, 4 of *Pinus*, 2 of *Abies*, 9 of *Taxus*, 6 of *Thuja*, and 4 of *Tsuga*. The broadleaf evergreens consisted of 21 species and varieties of 13 genera. There were also 15 species and varieties of deciduous trees, 31 of deciduous shrubs, and approximately 2500 perennials.

The narrow-leaf evergreens were injured less by Sovasol No. 5 than any other class of ornamental nursery stock. Of these the junipers were most resistant; less so were pines, spruce, hemlocks, fir and arbor vitae; and least of all *Taxus*. The foliage of *Taxus* is easily injured and if such spray wets the base of the trunk, or is allowed to run down the trunk to the roots, the plant may be killed. Deciduous trees and shrubs varied in the amount of oil that damaged the bark at the base of the trunk or stem, but the foliage on all was "burned" by small amounts of spray. This observation also applied to herbaceous perennials. Since foliage injury, particularly to salable-size ornamental plants, seriously impairs sale value, it is advisable that Sovasol No. 5 be applied in a manner that will cause a minimum of injury. At present the most practical method is by hand spraying when the weeds are small.

Preliminary trials for pre-emergence weeding of gladiolus bulblets indicated that this is a practical method to eliminate the first weeding. Later applications, after the gladiolus plants were up, were not feasible since the plants are badly injured by weed killers such as Sovasol No. 5.

Information obtained from this project was given to visiting nurserymen and others, by talking with them and by demonstrating the method of using Sovasol No. 5 to avoid injury to nursery plants. As a result, one progressive nurseryman used 2500 gallons in his nursery last summer. In one block of large arbor vitae on heavy soil, the overgrown weeds were first scythed down and then manually sprayed with oil at an estimated cost of one-third that of horse cultivating and hoeing by hand. Other nurserymen also have adopted this method of weed control, and it is gratifying that increasing numbers come here seeking information about it.

Studies are planned to determine the reaction of additional nursery plants to Sovasol No. 5; and susceptibility to injury on plants of different ages and in different stages of growth. Other weed killers will be tested for possible use in the nursery.

**Factors Influencing the Rapidity of Growth of Nursery Stock.** (C. J. Gilgut, Waltham.)

*Leaf Bud Cuttings of Rhododendrons.*—Leaf bud cuttings of 19 named varieties of hybrid rhododendrons were taken in June and August and propagated in sand and mixtures of sand-peat in proportion of 1:1, 1:2, and 1:3. The effects of rooting medium and six commercial root-promoting hormones were compared. The best rooting was obtained with Hormodin No. 2 powder treatment, and indolebutyric acid 60 mg. per liter for 24 hours. Sand-peat mixtures were better than sand alone.

There was a decided difference in varietal response to rooting. *Roseum elegans*, *album elegans*, Gomer Waterer, and Lady Armstrong rooted in larger numbers than the others.

*Rooting of Cuttings of Jane Abbott Azalea.*—The desirable pink azalea, Jane Abbott has resisted attempts to propagate it vegetatively. It failed to root in sand, sand-peat, cinders-peat, vermiculite, vermiculite-sand, and vermiculite-peat when cuttings were taken in mid-April. Treatments with commercial root-promoting hormones did not help.

If cuttings are taken at the right time they may root, and this phase will be investigated to a limited extent.

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## DEPARTMENT OF OLERICULTURE

G. B. Snyder in Charge

**Asparagus Investigations.** (Robert E. Young, Waltham.) Considerable progress was made during the year in an experiment designed to develop a higher-yielding strain of asparagus. The third generation of plants was cut for the first full cutting period. The yield of spears from the best strain was slightly more than 1 pound per plant, as compared to 0.6 and 0.7 pounds per plant for the two commercial strains. When considered on an area basis, the yield of the better selections was almost double that of the commercial lines. This is due to a greater loss of plants in the commercial strains.

The increase in yield was obtained through a greater number of spears, not through larger size. Both the best selections and the commercial lines produced a crop which graded approximately 50 percent fancy; some smaller strains were as low as 32 percent fancy. The strains which produced the small-sized spears (average weight 16 gm.) came from parents whose average spear weight was 18 gm. The largest strains produced spears with an average weight of 20 gm., and came from parents which produced spears with an average weight of 27 gm.

There was considerable difference between strains in early production. As much as 25 percent of the total crop was harvested the first week from some, while others produced more nearly the same quantity for each of the six weeks cutting period. The earliness factor is important because of higher prices received at the beginning of the season. Early yield was not definitely associated with high total yield.

After the first full cutting season the number of stalks produced during the summer dropped 21 percent from the previous year. The better-producing strains did not show as much reduction as the low-yielding ones.

There was no loss of plants during the year. There was a heavy cover of snow over the plants all during the coldest weather, and this substantiates the theory that the loss of asparagus plants is due largely to winterkilling.

In the second generation planting the biennial bearing effect which has shown up the last few years was discontinued and the yields were the same as the previous year. The yield relationships between the strains remained the same as previously reported. No rust appeared on any of the plants.

**Vegetable Breeding for Improvement of Quality.** (Robert E. Young, Waltham.) Progress has been made in the development of strains of carrots and cabbage better adapted to local use. Work was along the lines previously indicated, but new developments are not conclusive enough to warrant detailed report at this time.

**Broccoli.**—Trials of fall broccoli, both at the Field Station and on growers' farms, again showed the value of the two strains developed for fall use. Broccoli is so easily affected by weather, and fall weather is so variable, that it appears questionable whether one strain of broccoli can be developed that will always be

superior. By using two strains of different environmental response, the grower can spread the risk. Neither Waltham 11 nor Waltham 29 has been a complete failure regardless of the weather, but this is not true of commercial strains. During the past fall, Waltham 11 produced more No. 1 broccoli than Waltham 29 or any of the commercial varieties. Sufficient seed of both Waltham 11 and Waltham 29 was distributed to growers to provide ample plants to determine the real value from a production standpoint. These strains showed up well, and the local market gardeners association is having seed produced for members.

Trials of selfed lines again indicated, as previously reported, that selfing, while improving uniformity, narrows the adaptability. Improvement is being continued by mass selection.

The spring crop of broccoli was almost a failure owing to an unprecedented infestation of clubroot and the ineffectiveness of the material used for cabbage maggot control. Sufficient selections were made to carry along the Waltham 7 material, but yield data were not available.

*Trellis Tomatoes.*—Because of the excessive rainfall during June, about half of the plants in the trellis planting were affected by root rots, and the plants were so stunted and delayed as to make yield data of questionable value.

Waltham Scarlet, the new variety developed for home garden use, met with a favorable reception and seed sales by one company were three times as much as during the previous year. While this variety is a little late for early trellis use, the high percentage of No. 1 fruits produced makes it valuable to growers as second early or fall crop. This variety won first prize for one grower in Field Day competition. Favorable comment has been received from its trials in other parts of the country, particularly Florida.

Both at the Field Station and on growers' farms, the results of trials of hybrid tomatoes developed at Waltham show all of these to have less tendency to set under adverse weather conditions than the standard varieties, such as Trellis No. 22 and Waltham Forcing. These hybrids have been developed for high early production of fruit but under the adverse conditions of last year they were not superior.

Early tomatoes have always been profitable, and since the weather during June is often adverse for setting a high percentage of the blossoms of the first and second cluster, a commercial hormone product for fruit setting was tried. These trials were made at the Field Station and on farms of two growers. Under the conditions prevailing on one grower's farm, two sprays applied to the blossoms a week apart resulted in an increase in set of the bottom cluster from 27 to 77 percent. The fruits ripe by July 30 were none for the check and 2.81 per plant where the sprays were applied. On the other farm, where the plants were not so vigorous, three sprays increased the set from 60 to 75 percent. Ripe fruit by July 30 was increased by the treatment from 1 to 2.78 per plant.

Two trials were made at the Field Station. On early plants the use of hormone sprays applied three times increased the set of blossoms from 62 to 84 percent. The yield of the sprayed plot at the first picking was almost three times that of the untreated, but the increase for the first two pickings amounted to only 8 percent. The application of three sprays to some later plants resulted in a reduction in the percentage of the blossoms set from 60 to 55 percent. However, the yield for the first two pickings was 51 percent greater from the sprayed plot than from the check. The hormone treatment caused a reduction in total yield in both trials.

If further trials confirm these results, the use of hormone to set the fruit in adverse weather will be well worth the cost.



*Greenhouse Tomatoes.*—Trials of tomatoes in the greenhouse have shown that a hybrid, Waltham Forcing X Michigan State Forcing, has consistently produced more fruit than Waltham Forcing and a higher percentage of No. 1 fruits. In the fall crop last year the hybrid produced 15.1 percent more No. 1 fruit and 6.9 percent greater total yield. Growers who have tried this hybrid have found it well worth while.

*Celery.*—As the result of single plant selections over a period of several generations, a strain of Summer Pascal celery has been developed, especially suited for use where celery is grown to maturity in the hotbed. It also has shown faster growth early in the season when the temperature is low. This celery has been developed in cooperation with a grower and is now ready for testing by others.

*Lettuce.*—The results of lettuce trials show that some progress is being made in the development of a better lettuce for Massachusetts. During the past year, the weather was so favorable as to bring about almost 100 percent heading in the set lettuce crop and thus afford little opportunity for selection. The lettuce crop seeded in the field headed at a time when the weather was warmer, and there were several strains and selections better able to withstand the warmer weather than the commercial varieties. Further work under more adverse weather will be necessary to complete selections.

Of the new varieties of lettuce tried, Premier Great Lakes produced well and was early. When planted later it tends to tipburn internally. Pennlakes showed up particularly well when seeded in the field. Both of these are recommended for trial by local growers.

The work of selecting a strain of Great Lakes lettuce adapted to local conditions has been started. Of the 10 strains tried from as many seed producers, none seemed to be alike and some were so different that they should be given other names or numbers. For the past two years there has appeared in the fields of Great Lakes lettuce when the plants were set early, a half-sized plant that is not sufficiently large for market. With the same seed, under warmer growing conditions, no small plants showed up. It is believed that these plants are particularly affected by cold weather. They have appeared in some strains up to 20 percent of the crop. Selection of the stock seed under warm California conditions is probably the cause, and a locally adapted strain would eliminate this loss.

*Butternut Squash.*—The program of developing a better Butternut squash has reached a point where inbred lines show no squash too long, while some commercial lines run as high as 12 percent. Other lines show no crooked squash, and the percentage of cull squash has been reduced from a normal of 25 percent to as low as 12 percent. Cracking of the fruit has also been reduced by selection. It is now the program to blend all of these characters into one strain and still maintain good yield, color, and shape.

Farmers always have had trouble getting Butternut squash seed to germinate satisfactorily during adverse weather. Experiments were conducted to determine what effect maturity and storage had on germination. It was found that the more mature the squash at harvest the better the germination of the seed. If the squash was mature, storage before seed removal did not increase germination; but with immature squash both seed weight and germination increased during storage.

In another test, squash which developed early, in mid-season, and late were so tagged. Seed was removed at early, mid-season, and late parts of the storage period. All of these lots of seed germinated over 96 percent in the laboratory. Also, they all germinated well in soil under favorable conditions; but when the

temperatures were lowered germination dropped, and only seed from those squash that developed early in the growing season and were stored to the mid-season or late period before seed was removed germinated satisfactorily. Further work is necessary to determine the conditions under which high-germinating seed can be produced.

**Weed Control in Vegetable Crops.** (William H. Lachman.) Hand weeding was eliminated in fields of set onions by the use of a  $1\frac{1}{2}$  to 2 percent spray of potassium cyanate applied when the weeds were dry and while they were quite small. Lamb's quarters and grasses become resistant to this treatment when they become larger than one half to three fourths of an inch tall. Three to four treatments were necessary throughout the season. Where the potassium cyanate was directed at the weeds so that the tops of the onion plants were not covered by the spray, yields were not reduced below those on carefully hand-weeded plots.

Pre-emergence application of several chemicals controlled weeds well for a period of four to six weeks in fields of sweet corn. The cheapest material used was 2,4-D; but it may damage corn or fail to kill weeds under certain conditions. Best results with 2,4-D were obtained with an application of  $1\frac{1}{2}$  pounds, acid equivalent, per acre, sprayed on land about six days after planting. Two other materials which appeared promising when applied immediately after planting are sodium pentachlorophenate (10 pounds) and Dow Contact Weed Killer (2 pounds DNOSBP).

Post-emergence applications of 2,4-D were not particularly beneficial since they had little or no effect on grasses, and such treatment made the corn stalks brittle and often prevented proper development of brace roots.

Dow Contact Weed Killer was outstanding in its effect on weeds in pre-emergence applications to snap beans. Two to three pounds of DNOSBP did not affect the yield and held weeds in check for four to six weeks.

Fall applications of isopropyl phenyl carbamate in spinach plantings left treated plots free of weeds the next spring without apparent harm to spinach plants. The control of chickweed with a 5 and 10 pound application of this chemical was especially noteworthy.

**Breeding Sweet Corn, Peppers, and Field Tomatoes for Massachusetts.** (William H. Lachman.)

*Sweet Corn.*—Nearly five thousand plants were self-pollinated during the year in the program to develop inbreds for the production of early types of Golden Cross Bantam sweet corn. These early types of P39 and P51 hybrids were developed by a backcrossing procedure and are now approaching uniformity. One hybrid involving this material as parents has the Golden Cross type of plant throughout and the ear matures in the Marcross season.

Gold Mine (Mass. 2410-191 x 63) continues to mature very early in competitive trials and about one ton of seed was sold to farmers this year. Work is in progress to improve the stiffness of stalk and ear appearance by using a three-way cross involving either C12 or C13 as the third parent.

One and one-half tons of Golden Jewel (2412-2 x 2412 1) x Maine 2 seed were produced and sold to farmers this year. This hybrid combines exceptional quality and appearance and matures in the Carmelcross season. Work is in progress in the attempt to advance its season of maturity somewhat.

*Peppers.*—Further trial indicates that Worldbeater selection III-1-1-3 is resistant to tobacco mosaic and is quite productive of very desirable fruit. Wind-sor Resistant selection I-1-4-2 is also mosaic resistant but did not yield well

during the past year. Several new selections from an  $F_2$  population are very early in maturity although their disease resistance is questionable.

*Tomatoes.*—Several selections from a cross between Bounty and Stokesdale (32-1-2-2) produced a good yield of large, smooth fruits in season with Bonny Best. The fruits were covered well with foliage, and several strains are now quite uniform. The cross of Red Cloud by Pennheart provides a hybrid that is very early, although the cover of foliage is not sufficient. An  $F_2$  population from this cross produced some very desirable early segregates.

#### **The Culture and Nutrition of Vegetables.** (William H. Lachman.)

1. A peculiar chlorosis on the leaves of greenhouse tomatoes is similar in its reactions to the chlorosis of plants affected by magnesium deficiency. Additions of potash definitely aggravated the condition; magnesium sulfate or dolomitic limestone plus additions of barnyard manure lessened or delayed it.

2. Several growth substances were found to set tomatoes, even where the flowers were emasculated before anthesis, and appear to have value for early planted crops where ordinarily the first blossoms often absciss. In dry weather, fruits set by means of these chemicals appeared to be more subject to blossom end rot than fruits set normally.

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### **DEPARTMENT OF POMOLOGY**

A. P. French in Charge

**Influence of Chemical Treatments on Flowering and Fruiting of Fruit Trees.** (F. W. Southwick and W. D. Weeks.) In the spring of 1948 emphasis was placed upon the use of chemicals for thinning apples at blossom time and later. Since the dinitro materials are strictly blossom-thinning materials, the sodium salt of naphthaleneacetic acid (NaNAA) was used exclusively at calyx and up to 4 weeks from calyx. Also, attempts were made on Wealthy and Delicious to determine why NaNAA caused some flowers and young fruits to absciss and not others, and how soon after its application this increase in rate of abscission occurred.

Early McIntosh trees sprayed with 1 pound of DN-1 at blossom time or 8 ounces of NaNAA at calyx gave a larger yield of apples  $2\frac{1}{2}$  inches and up in diameter than hand-thinned trees. Total yield from the trees sprayed with DN-1 was also greater than that from hand-thinned trees. The trees receiving NaNAA, however, were more heavily thinned than those receiving DN-1 and had a smaller total yield than the hand-thinned trees. DN-1 resulted in more russetting and cracking and poorer finish than occurred on the hand-thinned or NaNAA-sprayed trees. However, NaNAA applied at calyx caused considerable curling and dwarfing of the spur foliage.

Wealthy spur flower buds 4.8 mm. in diameter and larger when dormant, set more heavily than those under that size, and NaNAA reduced the set much more markedly on those spurs bearing small flower buds. The period of increased rate of abscission on Golden Delicious, following applications of NaNAA at calyx and 4 weeks from calyx was not immediate. The fruit which was caused to absciss slowed down in its rate of enlargement and an increased rate of dropping did not occur until 9 to 12 days after the NaNAA was applied.

Somewhat to the surprise of the investigators, the McIntosh and Golden Delicious trees sprayed with NaNAA in 1948 at 2 and 4 weeks from calyx bloomed much more heavily this year than those spray-thinned at calyx with the same



material. The calyx-thinned trees bloomed only slightly more than the unthinned trees which produced only 5 to 10 percent of a full bloom. The explanation of these results is not entirely evident at present. Since late thinning (2 to 4 weeks from calyx) appeared to be considerably safer (from the standpoint of judging the extent of fruit set and foliage injury) than blossom or calyx applications of NaNAA, this finding may have considerable practical importance. Heretofore, it has been supposed that chemical thinning at calyx was more apt to result in annual blossoming than thinning done later.

Tests conducted in the spring of 1949 are located in 5 commercial orchards and at Amherst. After-calyx applications of NaNAA for thinning have been applied to Early McIntosh, McIntosh, Wealthy, Gravenstein, Duchess, Red Astrachan, Golden Delicious, Kendall, Baldwin, Rome Beauty, and Delicious. Some preliminary work covering late application of NaNAA on pears, peaches, and plums have been started.

Publication: Southwick, F. W., and Weeks, W. D. Chemical thinning of apples at blossom time and up to four weeks from calyx. *Proc. Amer. Soc. Hort. Sci.* 53:1949 (In press).

**Storage Investigations.** (F. W. Southwick, H. N. Stapleton, and F. Emmert.) Work in 1948 included the following:

1. Methyl naphthaleneacetate at concentrations of 1000 p.p.m. hastened the respiration, softening, and ground color development of harvested preclimacteric apples.

2. Harvested green tomato fruits appear to go through a well-defined preclimacteric, climacteric, and postclimacteric respiratory cycle which is similar to that of harvested preclimacteric apples. When red color appears the fruits are no longer preclimacteric. It is hoped that preclimacteric greenhouse tomatoes may serve as a substitute fruit for apples in respiratory studies of possible ripening inhibitors when preclimacteric apples are unavailable.

3. Concentrations of 1 to 5 gallons of Dowax 222 per 100 gallons of water as sprays or dips had no consistent influence on the rate of softening or scald development on apples. The same may be said of Plast-O-Trete at dilutions of 1 to 4 and 1 to 10 with water.

4. The use of activated carbon reduced storage scald of Cortland apples by 80 percent.

5. McIntosh stored at 5 percent carbon dioxide and 3 percent oxygen at 40°F. were slightly firmer when removed from storage in March than similar apples stored in air at 32° to 34°F. The apples from the modified atmosphere room remained marketable for 3 to 4 weeks when left at room temperature as compared to one week for the cold storage apples.

6. Lots of Howard 17 strawberries still showing white tips were subjected to temperatures of 34°F. and 50°F. in air and in one series to 15 to 20 percent CO<sub>2</sub> at 50°F. from 2 to 4 days (before being subjected to room temperatures), to determine how they compared with similar berries held at room temperature (70° to 90°F.) continuously. All refrigerated berries kept quite well for the short periods that they were under refrigeration and were markedly superior to unrefrigerated berries which were completely rotten in 2 to 3 days. The lots at 50°F. with 15 to 20 percent CO<sub>2</sub> were in somewhat firmer and less mature condition than those lots held in air at 50°F. and 34°F. when they were placed at room temperature. They remained marketable for ½ to 1 days longer than the other refrigerated lots, due largely to the fact that they rotted less rapidly. There was no marked difference in keeping quality between berries held for 2 days at 34°F. and those held for 2 days at 50°F.

Publication: Southwick, F. W. Further studies on the influence of methyl a-naphthaleneacetate on the ripening of apples and peaches. *Proc. Amer. Soc. Hort. Sci.* 53:1949 (In press).

**The Influence of Various Clonal Rootstocks on Apple Varieties.** (W. D. Weeks and F. W. Southwick.) For the first time since the orchard was planted in 1939 the McIntosh crop was large enough for comparisons of the effect of stock on yield. Trees on Malling IV and XV had significantly smaller yields than those on Malling I, II, III, V, XII, XIII, and XVI. Malling XVI produced the largest tree and crop. The crop on Malling I and II was nearly as large as that on XVI but tree size was intermediate. Trees on Malling XII were nearly as large as those on XVI but their average yield was considerably lower. Trunk cross-sectional area measurements of trees on Malling XV revealed that they are no larger than trees on V and III, although Malling XV is supposed to produce as large a tree as XVI.

**Study of Tree Characters of Fruit Varieties.** (W. D. Weeks, A. P. French, O. C. Roberts.) Buds of the Milton and Farmington strain of Black Tartarian sweet cherry were obtained from the Utah Station for comparison with Tartarian and false Tartarian which are grown by eastern nurseries. As one-year whips the Utah strains appear to be different from either of the two types of Tartarian grown by eastern nurserymen. This suggests that there is more than one type of sweet cherry being propagated for Black Tartarian.

New varieties of apple and pear were propagated for study.

The work of inspecting fruit tree nurseries for trueness-to-name was continued and 28 nurseries were inspected during the year. One nursery in Ohio was inspected for the first time. The number of misnamed trees found was no greater than that of past years. The prompt elimination of small mixtures prevents them from becoming larger and eliminates the danger of the grower obtaining a large number of misnamed trees.

**The Nutrition of Apple Trees.** (In cooperation with Chemistry and Agronomy.) (W. D. Weeks, F. W. Southwick, Mack Drake, Dale Sieling.) This project was initiated during the year to find out what effect different levels of nitrogen in the tree have on growth, yield, color, and keeping quality of fruit. Different levels of nitrogen will be maintained by soil applications of mulching materials, nitrogen fertilizers, complete fertilizer, and nitrogen applied as urea by foliar sprays. The effect of the differential fertilizer treatments on the chemical composition of the foliage will be determined by leaf analyses.

Leaf samples were collected from the midportion of the shoots of each of 125 fifteen-year-old McIntosh apple trees early in August, 1948, and analyzed for total nitrogen, phosphorus, potassium, calcium, and magnesium. Chemical composition of leaves and trunk diameters were used as a basis for pairing trees which constitute plots in the experiment, and also furnish a basis for studying effects of fertility treatments on leaf composition.

Initial surface and subsoil samples were taken.

The grass hay used for mulching had been field baled and varied considerably in nitrogen, phosphorus, potassium, calcium, and magnesium. The bales were broken, thoroughly mixed and rebaled with the result that the variation was reduced to about one-half that of the field-baled material. This hay was very low in calcium and magnesium, suggesting that applications of calcium-magnesium limestone may be required in orchards which receive mulch of this composition.

**Study of Bud Sports of the McIntosh Apple.** (W. D. Weeks and F. W. Southwick.) The 1948 crop from the orchard of 7 strains of McIntosh was in sufficient

quantity to permit a detailed examination of each strain. Amount and type of red color was studied. Strain R had the greatest amount of color; 92 percent of its crop had apples with 90 percent or more of red color.

Strain R was the only blush type which did not have some striped apples. Two-thirds of the crop from strain 12, a blushed type, was striped. The amount of striped fruit varied from 1 to 7 percent for the other blush strains. The apples of strain 39, a striped type, were all striped. From these results it appears that there may be superior strains of McIntosh insofar as type and amount of red color is concerned.

As soon as the crop is of sufficient volume, studies of preharvest drop, storage life, and quality will be made.

**The Nature of Winter Hardiness in the Raspberry.** (J. S. Bailey and F. W. Southwick.) Since 1944 an experiment has been carried on to compare cultivation with cover crops and hay mulch as cultural systems for red raspberries. In 1946 the cultivated plot was divided in half. One half received nitrate of soda annually at the rate of 225 pounds per acre; the other half at the rate of 450 pounds per acre. Likewise, the mulched plot was divided in half. One half received no additional nitrogen; the other, nitrate of soda annually at the rate of 225 pounds per acre. Differences in winter injury under the two systems of culture had been slight through 1945. From 1946 to 1948 differences began to show up in certain varieties. The two hardy varieties, Chief and Latham, were not injured severely and type of cultural treatment made no difference. The tender varieties, Marcy and Washington, were severely injured under both cultural systems. The varieties Milton and Taylor were injured much more severely under mulch than under cultivation. The differential fertilization with nitrate of soda appeared to have no effect on amount of winter injury. A paper, "Winter injury to red raspberries as affected by cultivation or mulching," by J. S. Bailey will appear in an early volume of the Proceedings of the American Society for Horticultural Science.

**Blueberry Culture.** (J. S. Bailey.) In the spring of 1948, in cooperation with Prof. A. I. Bourne, D-542 and D-289 were compared for the control of a Lecanium scale. D-542 was very effective. D-289 was less effective and was suspected of causing injury to the blueberry bushes. In the spring of 1949, D-289 was compared with tank-mixed superior oil. Both were effective in controlling the scale, but the superior oil was slightly better. Neither caused observable injury to the blueberry bushes.

In the spring of 1948, in cooperation with Dr. F. R. Shaw of the Entomology Department, the effect on bees of dusting blueberries with DDT while they are in bloom was studied. Adverse effects were slight, if any.

The blueberry stunt disease was watched for any additional evidence of its spreading. Three new cases, involving an additional variety, were found in the Station planting. A few new cases were found in the Cape Cod section. It is now evident that this disease is spreading slowly in Massachusetts.

There was considerable winter injury to cultivated blueberries in the Station planting during the winter of 1947-48. Varieties were rated as to winter injury as follows:

Very severe: Cabot, No. 73, Grover.

Severe: Sam, June, Scammell, Stanley, Pioneer.

Medium to severe: Adams, Burlington, Dunfee, Wareham, Dixi.

Medium: Pemberton, Concord.

Light to medium: Atlantic, Weymouth, Rancocas, Jersey, Rubel.

Light: Katherine.



Seven of the new U.S.D.A. selections fruited for the first time: DK-71, BM-22, A-91, T-72, X-58, DN-76, and U-25. While it is too soon to evaluate these, DK-71 looks the most promising at present.

**Nutrition of the High-Bush Blueberry, Especially in Relation to Soil Reaction.** (J. S. Bailey, C. Tyson Smith, and Robert T. Wetherbee.) The chemical leaf-analysis studies of 1947 were continued and expanded. Leaf samples were collected in July and in September from eight plantings in the Cape Cod section where the bushes were growing vigorously and bearing well. Samples were also collected from the Experiment Station plantings in Amherst. Again, the leaf content of P, K, Ca and Mg was found to be low compared with that of other fruits. Leaf nitrogen content was about what one would expect in apple leaves of normal vigor. From July to September P decreased; K was variable, increasing in some cases and decreasing in others; Ca increased; and Mg did not change significantly in half the cases, in the other half it increased.

Leaf analysis showed no increase in leaf Mg resulting from soil application of  $MgSO_4$ , but some increase resulting from spraying with  $MgSO_4$ . A report of this work, "The Nutritional Status of the Cultivated Blueberry as Revealed by Chemical Analysis," by J. S. Bailey, C. T. Smith, and R. T. Wetherbee, will appear in an early volume of the Proceedings of the American Society for Horticultural Science.

**Improvement of the Wild Low-Bush Blueberry.** (J. S. Bailey, W. D. Weeks, C. E. Cross, and F. R. Shaw.) This project was started in the spring of 1949. Emphasis is being placed on insect control, weed control, and fertilization.

Infestations of the blueberry flea beetle were light to very heavy in some locations in the Granville area. Parathion applied either as a dust or as a spray was very effective in controlling this insect and caused no observable injury to the blueberry plants. Very few adults emerged in places which had been treated during the larval stage. The infestation was spotty and many of these spot infestations were not found until blossom time. It was necessary to make applications during bloom, thereby endangering bees, in order to control the beetle larvae.

**The Effect of Benzene Hexachloride Sprays on the Flavor of Peaches.** (J. S. Bailey, W. B. Esselen, and E. H. Wheeler.) Since benzene hexachloride looked so promising for the control of curculio in peaches but had caused an off-flavor in some places, an experiment was set up in 1948 in a variety peach orchard to check on the production of off-flavor. A 50 percent wettable powder of benzene hexachloride containing 6 percent gamma isomer at 2 pounds per 100 gallons was applied to 36 varieties of peaches on May 29, June 3, and June 10. Tree ripened fruits were canned, frozen, and tasted as fresh fruit. No off-flavor attributable to BHC was detected in the frozen or fresh products. When canned, only 4 varieties showed no off-flavor. Detectable off-flavor in the other 32 varieties ranged from slight to strong and very strong. No correlation was observed between flesh color or season of ripening and the intensity of off-flavor. A report of this work, "Off-flavor in Peaches Sprayed with BHC," by John S. Bailey, William B. Esselen, Jr., and Ellsworth H. Wheeler will appear in the Journal of Economic Entomology.

**Control of Weeds in Fruit Plantings.** (J. S. Bailey.)

**Apples:** Sodium trichloroacetate was applied at rates of 50, 100, and 150 pounds per acre to trees 25 years old and to trees the year after planting. About half the grass was eliminated by 50 pounds per acre; 95 percent or more by 100 or 150 pounds per acre. None of the concentrations produced any visible effect

on the older trees, but 150 pounds per acre appears to have delayed foliation slightly on the young trees.

*Blueberries:* Sodium trichloracetate was applied in August at rates of 37.5, 75, 112.5, and 150 pounds per acre. The lightest application caused a marked delay in foliation and failed to control grass. The bushes which received the heaviest application will probably die.

Bushes which received two applications of a proprietary mixture, containing 0.5 pound of dinitro-ortho-secondary butylphenol per gallon, at 3 gallons per 100, plus 10 gallons of fuel oil, to mow the grass and weeds showed no visible signs of injury.

*Peaches:* A proprietary mixture, containing 0.5 pound of dinitro-ortho-secondary butylphenol per gallon, at 3 gallons per 100 gallons of water, with and without 10 gallons of fuel oil, was tried for mowing grass. The fuel oil increased the effectiveness of the spray. No visible injury to trees occurred.

*Raspberries:* Sodium trichloracetate at 50 pounds per acre, applied in August, caused a marked delay in foliation in the spring of 1949.

Ammonium sulfamate, applied in late August at the rates of  $\frac{3}{4}$  and 1 pound per gallon and 1 gallon per 100 square feet, eliminated all weeds except a few clumps of grass. Most raspberry plants appeared uninjured.

A proprietary mixture, AMCC, in fuel oil was no more effective than fuel oil alone. Another proprietary mixture, NIX, was ineffective.

*Strawberries: Fruiting bed.* Flowers were affected by 2,4-D at a concentration as low as 1 pound per acre. IPC (isopropylphenylcarbamate), broadcast dry at 5 or 10 pounds per acre, had no effect on either strawberries or weeds.

Stoddard Solvent at 100 gallons per acre was exceedingly toxic to strawberries. Dow Contact Herbicide was too toxic to strawberries, as was also phenyl mercuri acetate (PMA), even at a concentration as low as 1:8000. The addition of 2,4-D to PMA increased the toxicity to strawberries.

*Strawberries: Newly set bed.* Applications of 2,4-D at the rates of 1,  $1\frac{1}{2}$ , 2, 4, and 8 pounds per acre were made before planting. Dry weather followed, and the treatments were not very effective in weed control. Four pounds per acre is too much for strawberries. Applications of 2,4-D made after the plants were set, following rain, were more effective in weed control.

IPC, broadcast dry at 5 pounds per acre, had no visible effect on either strawberries or weeds.

Ammonium sulfamate, applied before planting at rates of  $\frac{1}{2}$  or  $\frac{3}{4}$  pound per gallon, 1 gallon to 100 square feet, was too toxic to strawberries.

PMA injured strawberries, even at 1:8000 concentration.

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## DEPARTMENT OF POULTRY HUSBANDRY

F. P. Jeffrey in Charge

**Broodiness in Poultry.** (F. A. Hays and D. W. Talmadge.) Efforts are still being made to develop a completely non-broody line of Rhode Island Reds. The fact has been demonstrated that it is essentially impossible to develop a completely non-broody line by selective breeding because after many generations of selective breeding, the incidence of broodiness still stands at about 2 percent.

In the summer of 1947 the prolactin test was applied to all females in the non-broody line in an effort to locate the carriers of genes for broodiness. Results were not too satisfactory, very likely due in part to the presence of other hormones besides the prolactin fraction. Females that showed the least reaction to prolactin injections were used for breeding in the spring of 1948.

During the summer of 1948 prolactin was secured which was believed to be free of other hormones. Evidence was inconclusive that the prolactin hormone is a specific inducer of broodiness because not more than half of the control hens with broody history displayed broody behavior after receiving single or double doses of prolactin.

The last generation (1949) was hatched in part from two-year-old hens, some of which had been tested twice with prolactin and had given no evidence of broody behavior; and in part from yearling hens, all with one prolactin test and no broody behavior. No daughters from prolactin-tested dams have had time to complete their first laying year so that the value of this method of testing breeders is not yet determined.

The problem of deferred broody behavior is also being given further consideration so far as facilities will permit.

**Genetic Laws Governing the Inheritance of High Fecundity in the Domestic Fowl.** (F. A. Hays and D. W. Talmadge.) Changes in egg weight during the first laying year have been studied in six generations of Rhode Island Reds. The data show that egg weight normally declines after the maximum at the age of 10 to 11 months. There is a reduced feed consumption and a decline in body weight that do not appear to be associated with high temperatures. In this latitude the amount of decline in egg weight during hot weather is insignificant.

The Station flock of Rhode Island Reds has been bred without outside introductions for many generations, but close matings have been regularly avoided. The amount of inbreeding in the last five generations has been very slight, with a range from 2.85 to 5.33 percent, which is lower than would be expected by random matings where 35 to 40 families made up each generation. The data show that a pedigreed flock can be carried through many generations without inbreeding provided close matings are constantly avoided.

Viability in the flock bred for high fecundity has been given careful consideration. The highest mortality rate appeared during the month of June of the first laying year. In the last eight generations of pullets the mortality in June averaged slightly above 4 percent. The major causes of death were kidney and reproductive disorders.

Standards for selecting breeding females to raise the level of egg production have been given special consideration in eight generations of Rhode Island Reds. The data show that the flock was too small for further constructive selection and that the standards for progeny testing were too low.

Over a ten-year period the possible relation between family mortality rate and egg production of survivors has been studied. The data definitely showed that high mortality in families of chicks in the first eight weeks and in pullets between the ages of eight weeks and six months was consistently associated with high production of survivors. There was no association between mortality rate in families in the laying house and egg production of survivors for the first laying year.

Low house temperature has been shown to have a specific effect on egg production, but length of day appeared to have little effect.

Two new factors affecting egg production have been studied. It was noted that rate of production during the month of highest production was intimately



associated with production for the other eleven months of the pullet year. Rate of decline in production following the high month was also an important factor relating to egg production.

During a ten-year period low winter temperature has produced a higher incidence of winter pause but has not consistently increased the duration of pause. Viability as indicated by mortality rate in families does not appear to influence winter pause.

The importance of sustained high production in females has been demonstrated. Data show that those families that exhibit only a moderate decline in egg production from the first to the second laying year are superior for breeders. Such females are likely to give daughters with higher production and a lower mortality rate.

An examination of data on early embryonic deaths strongly indicates that female embryos die at a more rapid rate than males during the first eight days of incubation.

**A Study of Fertility Cycles in Males.** (F. A. Hays and D. W. Talmadge.) During the spring of 1949 all-night lights for 30 days, morning lights at 4 a.m. for 7 weeks, and no artificial lights (control) were used as treatments to activate 24 to 36 months-old males to higher fertility. The data showed the two methods of lighting to be about equally effective and both treatments superior to natural light only. Further data are necessary to determine whether a longer period of all-night lighting would be advantageous.

The inheritance phase of fertility in Rhode Island Reds has been further examined over a ten-year period. The data are strongly suggestive that sex-linked genes are operating to regulate fertility.

**Secondary and Adult Sex Ratio in Relation to Hatchability.** (F. A. Hays.) The fifth generation of selection to produce high and low hatchability lines has been produced. The two lines are definitely diverging but there are still a few females that fail to qualify according to the standards. The search for lethals producing low hatchability has continued.

Definite evidence has been presented showing that hatchability tends to decline as the parents grow older. This tendency is more pronounced in females than in males. One of the potent causes of this decline is increased early embryonic mortality. There is also an increase in the number of live chicks that fail to emerge from older parent stock.

**Breeding for High and Low Incidence of Internal Defects in Hen's Eggs.** (F. P. Jeffrey and C. E. Walker.) Among  $F_1$ ,  $F_2$ , and backcross ( $F_1$  male  $\times$  S.C. Rhode Island Red females) egg shell color segregates from reciprocal matings of S.C. White Leghorn and S.C. Rhode Island Red, it was found that the groups with the darkest egg shells carried more colored meat spots and fewer white meat spots than did the groups with tinted or white egg shells. These observations agree with previous findings taken within and between breeds.

**Breeding White Plymouth Rocks for Eggs and Meat.** (F. P. Jeffrey.) Observations on brooding house mortality (up to 6 weeks of age) over a five-year period indicate that the re-use of litter cannot be recommended for the grower of replacement pullets. It is true that strains can be "acclimated" to filthy brooding, but at the present time this has not been generally accomplished. Likewise there is real danger of increasing mortality from lymphomatosis on the range and in the laying house by the re-use of litter. It is desirable, however, for breeders to use litter over and over again. This is especially desirable for the breeder of "broiler" stock.

## SEED CONTROL

Frederick A. McLaughlin in Charge

Enforcement of the Seed Law, together with the desire of seedsmen to comply with requirements of this Act and a growing interest of the public in good seed, has greatly increased the number of service samples sent to the seed laboratory for testing. From July 1, 1948, to June 30, 1949, 7416 service and inspection samples of seed were received and worked at the laboratory, an increase of 458 over the previous year. The laboratory also received and cleaned 95 lots of tobacco seed.

Analysis of inspection samples shows that most seedsmen have complied with label requirements of the Seed Law. A large part of the violations found are technical in nature rather than flagrant.

Operation of the Seed Law is reported in an annual bulletin issued for that purpose.

## DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

**Poultry Disease Control Service.** (H. Van Roekel, K. L. Bullis, G. H. Snoeyenbos, O. S. Flint, F. G. Sperling, M. K. Clarke, O. M. Olesiuk, A. M. Crotty, S. M. O'Grady, and A. C. Haskell.)

1. *Pullorum Disease Eradication.*—During the 1948-49 testing season, 569 chicken, turkey, and pheasant flocks were tested in 12 counties. A total of 1,241,500 samples was tested, of which only 0.04 percent were positive. This is the lowest percentage of positive tests for the 29 years of testing. No reactors were detected among fowl other than chickens. The percentage (1.55) of breaks in the negative flocks was the lowest in the last ten years of testing. Furthermore, 99.1 percent of all the birds tested were located in 100 percent tested, non-reacting flocks. Only five flocks were classified as infected at the close of the testing season.

The results reveal that further progress is being made in the eradication of pullorum disease from Massachusetts flocks. A more detailed discussion of the pullorum testing work will be given in the Twenty-Ninth Annual Report of Pullorum Disease Eradication in Massachusetts.

2. *Salmonella Pullorum Studies.*—During the past year 20 pullorum-infected flocks were detected through the testing and diagnostic services. A total of 94 infected birds was submitted to the laboratory, from which 275 *S. pullorum* cultures were isolated. An additional 69 suspicious reacting birds were examined and found to be negative. All cultures were extensively studied in regard to their antigenic composition and behavior. Only three mature birds obtained from two flocks were found to be infected with the antigenic variant form of the organism. These were the only infected birds in the flock and were readily detected by the standard antigen used in routine testing.

Six infected chick and poult flocks were found, which appeared to be infected with both the standard and variant forms of the organism. No flocks were found in which only the variant type was recovered.

Extensive investigation of the relationship between the antigenic form of the infecting organism and the agglutinating components of the serum from the corresponding bird has yielded valuable information concerning pullorum disease control methods. Part of these results are in the process of publication.

With this information, it is hoped that an antigen may be developed which will be more effective in detecting birds infected with the recognized antigenic forms than the one employed for routine testing at the present time. To date the results appear very promising for developing such an antigen.

3. *Diagnostic Service.*—During the 1948 calendar year, 5,180 specimens were received in 1,068 consignments, of which 742 were delivered in person. The specimens were classified as follows:—4,806 chickens, 275 turkeys, 26 quail, 13 canaries, 11 each of canine feces and guinea pigs, 8 equine feces, 5 pheasants, 4 bovine, 3 porcine, 2 each of chinchillas, mink feces, mink, and pigeon, and 1 each of cedar waxwing, fowl pox vaccine, goat feces, hamster, junco, lynx rufus, rabbit, raccoon, robin, and ruffed grouse.

The continuing increase in the amount of material coming to the laboratory for examination was due largely to the great demand for immunity tests for the purpose of having flocks included in the infectious bronchitis and Newcastle disease immunization programs. This is to be expected since infectious bronchitis and Newcastle disease are of great economic concern to the poultry industry. These two diseases are discussed further in another section of this report. Tumors (109), coccidiosis (102), and fowl paralysis (71) were other prevalent disorders as in previous years. Avian tuberculosis was identified in one flock. There were 21 diagnoses of fowl typhoid and 15 of fowl cholera, 14 and 9, respectively, representing new known foci of infection. The incidence of epidemic tremor and of nutritional encephalomalacia was considerably higher than that of the previous year.

Additional observations on the kerato-conjunctivitis in chickens reported a year ago suggest that ammonia fumes from the litter might be the causative factor. Attempts to transmit the disturbance by pen contact and transfer of material to the eyes of laboratory chickens have failed. Reports on affected flocks also indicate that no infectious agent is present.

The 275 turkeys were received in 59 consignments. This represents a further decline in the number of specimens being submitted to the laboratory and reflects in part a more stable situation in the turkey industry. Only one diagnosis of paratyphoid was made as compared with an average of ten for each of the preceding four years. Fowl pox and hexamitiasis were not identified for the third succeeding year. Two outbreaks of Newcastle disease in growing birds were detected. Penicillin was used to treat infected individuals in two outbreaks of erysipelas. Of the 72 birds treated in the first outbreak, 10 (13.9 percent) died. There was a mortality of 43 birds in a flock of 900 over a period of three weeks. Another group of 700 in an adjacent lot did not become infected when added to the first lot of 900. In the second outbreak, 29 (20 percent) of 145 treated birds and 5 (33 percent) of 15 clinically affected untreated controls died. There was a mortality of 85 birds in the flock of 3,000 over a period of 10 days.

4. *Flock Mortality Studies.*—Necropsies were made on 194 birds (152 females and 42 males) up to January 1, 1949, from the flock hatched in the spring of 1947 and maintained for genetic studies by the Poultry Department at the University. Infectious bronchitis was identified in the flock for the first time in September, 1948. The effect on egg production in the birds under consideration could not be accurately assessed as they were completing their first laying year and were relatively low in production. The egg production, which had reached 50 percent in a group of birds just beginning to lay, dropped to 16 percent within one week and remained below the pre-outbreak level for a period of more than two months; whereas the effect on birds about a month younger, which had not started to lay, was negligible. The egg shape and the shell texture did not regain normalcy for approximately three months in the adversely affected group. Reproductive



disorders, cannibalism, tumors, and kidney disorders were the principal causes of mortality in the flock. Gross examination indicated that the incidence of lymphocytoma (14 females and 1 male) and fowl paralysis (12 females and 1 male) was increased considerably over the previous year when four cases of each were recognized.

5. *Infectious Bronchitis Control*.—Respiratory diseases, especially infectious bronchitis and Newcastle disease, are of great economic concern to Massachusetts poultrymen. During 1948 a total of 434 flocks was enrolled in the infectious bronchitis control program, an increase of 171 flocks over the previous year. The results on the whole continue to be satisfactory, although an apparent break in the immunity occurred in a few flocks. Such cases will be investigated more thoroughly if they occur again.

During 1948 a total of 262 consignments was submitted for immunity tests for differential diagnosis of infectious bronchitis and Newcastle disease. Diagnosis for infectious bronchitis showed 227 positive, 4 doubtful, and 31 definitely negative. Six consignments, five positive and one negative, were from out-of-state flocks. A total of 968 serum-virus neutralization tests was conducted for infectious bronchitis diagnosis.

Of the 262 consignments which were submitted for differential diagnosis, 90 were positive for Newcastle disease, including one from out of state. Of the 239 consignments submitted for Newcastle disease diagnosis only, 83 were positive, 9 questionable, and 147 negative. A grand total of 173 positive diagnoses of Newcastle disease was made during 1948.

Eighty of the consignments submitted for differential diagnosis, were found to be positive for both infectious bronchitis and Newcastle disease.

6. *Newcastle Investigations*.—(a) During the past year studies on the use of live vaccine for immunization against Newcastle disease were continued. A total of 230 flock owners was supplied with the Massachusetts vaccine for Newcastle disease immunization. Approximately 770,000 birds were vaccinated. On the whole, the results were quite satisfactory. However, in the vaccination of commercial flocks it appears that live Newcastle vaccine must be prescribed with caution to the owner, since it may produce severe outbreaks in young chicks and may markedly affect egg production in laying birds. Even in growing birds, a mild to moderate outbreak may follow vaccination. Similar observations have been made regarding the use of commercial live vaccines. To reduce or eliminate these post-vaccination difficulties, the live vaccines need further investigation. The immunity produced following vaccination apparently is adequate to prevent natural outbreaks of the disease. Natural outbreaks have not been detected in vaccinated flocks up to the present time.

Simultaneous vaccination with fowl pox and Newcastle disease vaccines has also been investigated. Laboratory trials have given satisfactory results. In some cases in the field severe post-vaccination troubles have developed. However, it was difficult or impossible to determine whether the troubles were caused by the dual vaccination or might have occurred if the birds had been vaccinated only with the Newcastle vaccine. Age, health of the flock, and seasonal factors play a decided role in the post-vaccination results.

(b) Passive immunity to Newcastle disease in progeny from stock immunized either through natural infection or by vaccination was studied. Field observations have revealed that chicks from immune stock may contract the disease as early as six days of age. In limited laboratory trials, chicks from vaccinated stock did reveal a limited degree of immunity at nine days of age. These studies are being continued.

(c) Viability studies concerning Newcastle disease were initiated during 1948. An embryo-adapted strain of virus was tested for its viability when placed in contact with various materials and stored under a wide range of temperatures. Preliminary results indicate that Newcastle disease virus may be quite resistant when subjected to certain environmental conditions.

(d) Transmission of Newcastle disease virus through the egg was investigated. Previous studies failed to show transmission of the disease to chicks hatched from eggs obtained from flocks with active outbreaks of the disease. In a limited number of trials, eggs inoculated with Newcastle virus, of known pathogenicity for live birds, likewise failed to hatch chicks affected with Newcastle disease. It appears that Newcastle disease infective eggs are not apt to hatch infected chicks. The greatest source of danger appears to be that eggs containing the virus, if broken in the incubator or hatchery, might cause infection in young chicks.

**Mastitis Testing Laboratory.** (W. K. Harris and F. A. Goulet.) During the fiscal year of 1948-49 a total of 29,059 milk samples was tested, which is more than twice the number tested during the previous year. Of the total number, 18,806 were from 21 State institution herds, 1,159 from the University Farm Department herd, and 9,094 from 140 private herds. Included in the latter were 309 samples from one county agricultural school herd and 832 from three demonstration herds. In addition to the total number of samples tested, 125 were received in a condition unsuitable for testing.

The three demonstration herds were tested in cooperation with the current program of the Extension Service to establish a mastitis control demonstration herd in each county. The total number of cows on the initial test of these herds was 52. Of these, 20 (38.5 percent) were classified as negative, 23 (44.2 percent) as positive for mastitis not due to *Str. agalactiae*, and 9 (17.3 percent) as positive for infection with *Str. agalactiae*. Progress in control is favorable, but conclusions cannot yet be drawn.

A summary of initial tests of private herds revealed a lower percentage of infected cows (43.4 percent as compared with 48 percent last year), the greatest reduction occurring in the number of *Str. agalactiae*-infected cows in herds having 20 or more cows. A total of 239 reports was made on samples from private herds. Of the private herds tested during the year 38 percent have had more than one test.

The incidence of mastitis in the State institution herds as a group is less, the greatest reduction being in the number of *Str. agalactiae*-infected cows (22 percent as compared with 38 percent last year). This improvement can be credited to 7 of the 21 herds. Four other herds are free from infection with *Str. agalactiae*, one having been maintained free for more than two years, and two for more than one year. The University Farm Department herd is also free from *Str. agalactiae* infection and has been maintained thus for more than one year.

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### WALTHAM FIELD STATION

Waltham, Massachusetts

Ray M. Koon, in Charge

The members of the research staff of the Waltham Field Station are assigned to this branch by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Refer to reports of these Departments for results of investigations conducted at this Station.

## PUBLICATIONS

## Bulletins

- 437 Home Freezing in Massachusetts. By William B. Esselen, Jr., Katherine M. Lawler, and Carl R. Fellers. 35 pp. illus. November 1948. (Revised.)  
Home freezing of foods is arousing much interest. In Massachusetts freezing seems best suited as a supplement to other methods of home preservation. Questions frequently asked by prospective home freezer owners are answered.
- 445 Cranberry Insects in Massachusetts. By Henry J. Franklin. 64 pp. illus. January 1948.  
Insects take an annual toll of fully one-fifth of the cranberry crop in Massachusetts. Information essential for their control is herewith provided.
- 449 Annual Report for the Fiscal Year Ending June 30, 1948. 80 pp. illus. September 1948.  
The main purpose of this report is to provide an opportunity for presenting in published form recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.
- 450 Weather in Relation to Cranberry Production and Condition. By Henry J. Franklin and Chester E. Cross. 16 pp. July 1948.  
Weather studies have been continued at the Cranberry Station since Bulletin 433 was issued in 1946, and the results, presented here, seemed to justify prompt publication.
- 451 Weed Control in Vegetable Crops. By William H. Lachman. 60 pp. illus. September 1948.  
Weeds compete seriously with crop plants for moisture, nutrients, light, and air, and also add greatly to the labor needed for crop production. This bulletin presents the results of recent experiments in weed control which are pertinent to the culture of vegetables as they are grown in Massachusetts.
- 452 The Inheritance of Certain Fruit and Foliage Characters in the Peach. By John S. Bailey and Arthur P. French. 31 pp. illus. May 1949.  
The demand for better varieties is as old as peach growing. Lack of basic genetic information, however, has made the production of new varieties a slow trial-and-error process. The work reported herein was undertaken to supply some of this basic information as to how characters are inherited.

## Control Bulletins

- 136 Inspection of Commercial Feedstuffs. By Feed Control Service Staff. 24 pp. June 1948.
- 137 Inspection of Commercial Fertilizers and Agricultural Lime Products. By Fertilizer Control Service Staff. 16 pp. July 1948.
- 138 Twenty-eighth Annual Report of Pullorum Disease Eradication in Massachusetts. By the Poultry Disease Control Laboratory. 11 pp. July 1948.
- 139 Seed Inspection. By Seed Control Service Staff. 36 pp. November 1948.

## Meteorological Bulletins

- 715-723, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By H. N. Stapleton. 4 pp. each.



## Reports of Investigations in Journals

## NUMBERED CONTRIBUTIONS

- 628 Spontaneous lymphocytoma in a flock of chickens. By Carl Olson, Jr. *Amer. Jour. Vet. Res.* 9 (31):198-200. 1948.
- 629 Influence of light during storage on composition of Blue Hubbard squash. By Arthur D. Holmes, Albert F. Spelman, Charles J. Rogers, and William H. Lachman. *Food Res.* 13 (4):304-307. 1948.
- 630 Composition and nutritive value of fresh, cooked, and processed swordfish. By Antonio Lopez-Matas and Carl R. Fellers. *Food Res.* 13 (5):387-396. 1948.
- 634 A gauge tester for home pressure canners. By C. I. Gunness and C. R. Fellers. *Food Res.* 13 (4):336-339. 1948.
- 635 Estimation of polyuronide hemicelluloses in holocellulose from nonwoody plant material. By Emmett Bennett. *Analyt. Chem.* 20:642-643. 1948.
- 639 Effect of decomposition of added oat straw and alfalfa meal on solubility of soil copper in ammonium acetate. By Charles Hurwitz. *Soil Science Soc. Amer. Proc.* 12 (1947):195-197. 1948.
- 640 Density of feather pigment in Rhode Island Reds. By F. A. Hays, Carol H. White, and Ruby Sanborn. *Amer. Nat.* 82:107-117. 1948.
- 642 Simplified Blacet-Leighton apparatus for gas microanalysis. By Victor M. Lewis. *Analyt. Chem.* 21:635. 1949.
- 647 Changes in the egg weight of Rhode Island Red females during the first laying year. By F. A. Hays. Official Report of the Eighth World's Poultry Congress, pp. 151-158. 1948.
- 649 Effect of different processing procedures on venting and loss of liquid from home canning jars. By W. B. Esselen, Jr., and C. R. Fellers. *Food Tech.* 2 (3):222-227. 1948.
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MASSACHUSETTS :  
AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 459

SEPTEMBER 1950

## Annual Report

For the Fiscal Year Ending June 30, 1950

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The main purpose of this report is to provide an opportunity for presenting in published form recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

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UNIVERSITY OF MASSACHUSETTS  
AMHERST, MASS.

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MCNAMARA, MRS. ELIZABETH L., Cambridge.....	1951
DEELY, JOHN M., Lee.....	1953
HUBBARD, CLIFFORD C., Mansfield.....	1953
WHITMORE, PHILIP F., Sunderland.....	1955

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O'DONNELL, MARGARET H., Associate Director

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nomics and Farm Management  
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nomics and Farm Management  
†CAMPBELL, FRANKLIN, Floriculture  
CONKLIN, JOSEPH, Dairy, Feed, and Ferti-  
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GOULET, FERN A., Veterinary Science  
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Nutrition  
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Nutrition

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 MARTELL, JOSEPH A., Dairy, Feed, and  
 Fertilizer Laws  
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 MOLINE, JESSIE, Botany  
 OLESIUKE, OLGA M., Veterinary Science  
 PARKINSON, LEONARD R., Home Economics  
 Nutrition  
 PIERCE, VIRGINIA J., Agricultural Economics  
 and Farm Management

REYNOLDS, IONA M., Veterinary Science,  
 SHERBURNE, RUTH E., Economics  
 SPEAR, ARTHUR J., Home Economics Nu-  
 trition  
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 STANLEY, ALBERT M., Veterinary Science  
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\*In charge    †At East Wareham    ‡At Waltham    §On Military Leave

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# ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION-1949-50

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## DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

**The Marketing of Broiler-Hatching Eggs.** (A. A. Brown and R. W. Brundage.) For the second year the Department has carried on a study concerned with broiler-hatching egg operations of Massachusetts poultrymen. Last year's study was done on a small scale and served the purpose of familiarizing the enumerators with this relatively new industry. Results from the study were not extensive and therefore served more as a guide to, and background information for, further studies.

This year a sample was drawn from 302 flocks appearing on the Pullorum List published by the Massachusetts Development and Industrial Commission. More than 80 personal interviews were taken, of which 68 were usable. Broiler Cross flocks were concentrated upon.

Broiler-hatching egg-sales reached their peak during the last week in September, then declined steadily to 50 percent of the peak figure by mid-December. Receipts of broiler-hatching eggs at Del-Mar-Va from all New England reached their peak in mid-September but declined only 23 percent by mid-December, indicating that Massachusetts may be losing out to other New England states during the fall. Total Massachusetts egg production was increasing during the same periods and sales of eggs in this study reached a peak around November 1; so it is not a matter of production.

Over 70 percent of the producers were shipping broiler-hatching eggs on June 1, when the study began. The rest started shipping at various times throughout the entire season—one as late as December 1. About 35 percent of the poultrymen shipped continuously during the period; nearly 43 percent were cut off completely, mostly during October; and the remaining 22 percent had their shipments interrupted for an average of three weeks. These cut-backs and interruptions were brought about by the buyers, who notified the shippers of their intentions either just before they took effect or not at all. In nearly all cases where the producers shipped continuously, there was some sort of marketing agreement, written contract or other, between the buyer and seller.

The biggest single shift in channels of distribution brought about by these notifications was from the broiler-hatching egg to the auctions. Percentagewise, there was a marked shift from broiler-hatching eggs to other market egg outlets such as to retailers or wholesalers, and many that had the right matings shifted to replacement stock outlets. But compared to the total, it was the egg auction which received the bulk of these unwanted hatching eggs. It should be pointed out that, while it is a contributing factor, this surplus is not the sole cause of a drop in egg prices during the fall.

Approximately 40 strains of birds were found, of which 24 percent were classed as "My Own" strain, indicating that birds had been replaced from the producer's own flock for a number of years. About 14 percent of the birds were one strain of New Hampshires: the Rock-Hamps mating made up a third of the birds in this study, while Rock-Reds made up 20 percent, and straight New Hampshires 18 percent.

Further tabulations are being carried on in preparation for a report which it is hoped will be ready for release soon.

**Pricing Eggs on the Boston Market.** (A. A. Brown, B. E. Brown, R. W. Brundage, and Alden Manchester, Cooperative Agent, B. A. E., and Harvard University.) This study has developed along four major lines: (1) Interviews with principal handlers of eggs and agencies reporting the egg market, (2) Daily contact with principal handlers for reports on transactions in eggs, (3) Periodic contact with a group of poultrymen for information on egg sales, (4) Transcription of records on transactions in eggs by the major New England cooperative egg marketing associations. Most of the available pertinent data have been brought together and much of the processing has been done.

Most of the near-by eggs entering into wholesale channels during the period of our field work were priced directly or indirectly in terms of the prices reported by the Boston Herald newspaper. Interviews with the trade as well as with some producer groups indicated a lack of enthusiasm for the report—a lack which seemed to stem from their concept of the limited data available to the reporter.

Preliminary analysis of the data indicated several alternatives. First, there is a possibility of improving the present report. Second, there is a possibility of substitution. The U.S.D.A. market news service issues a daily report which includes eggs. The service has features which make it superior to the Herald. Third, the industry in New England might assume responsibility for providing its own statistical services including price reporting.

Custom, trade practice, and chance account for the continued use of the Herald report. Any successor to the Herald will depend largely on the desire of buyers and sellers or buyers or sellers to use something else. The situation is basically a management problem and only incidentally a statistical one (although the statistics could be appreciably improved).

**Fluid Milk Prices in Major Northeastern Markets.** (A. A. Brown, H. G. Spindler, J. A. Ward, and W. Bredo, Cooperative Agent, B. A. E.) Compilation of the Worcester-Springfield price series was continued and a paper, "Selected Statistics, Worcester Milk Market, June and November 1948," was published for use of interested parties at the Federal hearings held in August 1949 to consider an order for Worcester. Emphasis has been given, however, to the development of comparable f. o. b. and delivered Class and Blend price series for the major markets—Boston, New York, Philadelphia, Baltimore, Washington, and Pittsburgh. Monthly series since 1920 are now available on a 3.7 fat basis for all these points.

Fluid milk and cream (including ice cream) requirements have been determined as of November-December 1947 and May-June 1948 for each of the primary markets plus the major secondaries in the area. Supply areas (milksheds) have been established in terms of these requirements and associated transfer costs.

**Marketing Massachusetts Potatoes.** (R. A. Fitzpatrick, A. A. Brown, and J. A. Ward.) The first part of the study has been published as Station Bulletin 454. The second part is concerned with the distribution of the local crop, and thus far the principal results pertain to a survey of potato buying practices of retail store operators, made in March 1950. Although the data are essentially subjective, they are considered significant because of the content of the questionnaire and the design of the sample. The data show that Massachusetts potatoes are in a poor competitive status in Springfield stores. Many retailers have the opinion that Massachusetts potatoes are of poor quality, that they are carelessly graded and sized, and that the product cannot be relied upon throughout a season. However, it was found that potatoes from other areas were not consistently of good quality, and were also subject to complaints from customers.

It was found that many retailers were not well-informed on potato grades, and that the majority did not know the varieties of the potato in the store. Further, half of the men interviewed did not know that native potatoes can be obtained during the winter.

The survey also investigated package and varietal preferences of consumers. Considerable data were obtained on package preferences. Data on varieties show that consumers have little knowledge of potato varieties.

A pertinent subject investigated was the possibility of developing a market for low-grade potatoes equitably priced. The survey data show that people in all income areas have been sold on top quality at a top price. The majority of retailers said that the people would not take lower quality potatoes at a lower price. However, some retailers said that people would buy them, because the retailers were actually selling them at the time.

By and large, the retailer is indifferent to the state of origin of potatoes if good quality is maintained. He has to have a dependable supply of good quality because the public will stop patronizing his store if they are given poor potatoes. In many cases, one sale of such potatoes is sufficient to cause the loss of a customer to competitors.

The results of the store survey have been summarized in a mimeographed report entitled "Preliminary Report on a Survey of Potato Buying at Retail in Springfield, March 1950."

The analysis of distribution is continuing with an investigation of disposal of the 1949 Massachusetts crop.

**Production Adjustments on Representative Massachusetts Farms.** (B. D. Crossmon and H. R. Shaw.) Farm Management case studies are under way on 47 Massachusetts farms. The types of farming receiving the most study to date have been dairy, cranberries, and poultry. Studies of a few vegetable farms have been started. Detailed budgets have been prepared for several farms, indicating the enterprise structure, physical inputs and outputs, and receipts and expenses for a selected base period. The profitability of alternative adjustments on these several farms is being considered through the use of budgets as a base and by making appropriate modifications to prices, to combinations of enterprises, or to rates of using input factors. Five more dairy case write-ups were completed during the year.

A periodical checkup is being made on the progress of the 44 farms which are cooperating with the University of Massachusetts and Harvard University in a dairy farm management project. Seven representative cases have been mimeographed<sup>1</sup> for educational use of agricultural leaders in southern New England. Four cases were written up by B. D. Crossmon while the rest were developed by R. G. Wheeler, project leader at Harvard University.

The study of portable pipe irrigation on hay and pasture crops was begun in 1949. High investment costs ranged from \$25 to \$160 per acre while total annual costs per acre for irrigating ranged from \$15 to \$30 or more per acre. Additional

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<sup>1</sup> The seven case write-ups selected are reasonably representative of southern New England dairying are:

- (1) The One Man Specialized Wholesale Dairy Farm
- (2) The Intensive One Man Specialized Wholesale Dairy Farm
- (3) The Two Man, Specialized Wholesale Dairy Farm in the Hill Areas
- (4) The Intensive Two Man Specialized Wholesale Dairy Farm
- (5) The Two Man Dairy Poultry Farm in the Connecticut Valley
- (6) The Two Man Dairy Vegetable Farm
- (7) The Two Man Dairy Tobacco Farm in the Connecticut Valley



fertilizer is another cost item. The general application of irrigation to Massachusetts dairy farms appears limited.

At four irrigation schools involving 245 leaders, data were presented on fixed and variable costs in irrigation, as well as alternative costs to irrigation. A more complete write-up of irrigation costs in relation to particular farms is in second draft.

The case analyses have led the cranberry and dairy production specialists to evaluate their recommendations more carefully, in view of changing prices, costs, and technology. At cranberry meetings involving 235 operators, information was presented on costs of alternative ways of harvesting and performing other bog operations. Information on production adjustments was presented at regional meetings of leaders of the Farmers Home Administration and Farm Credit Administration.

The case studies provided fundamental material for two formal talks: (1) "Farm Yardsticks" at the Connecticut Rhode Island Agricultural Bankers School, Storrs, Connecticut and (2) "Timely Adjustments for Massachusetts Poultrymen" Poultry Day, University of Massachusetts. Attendance at those meetings numbered 100 and 350, respectively.

Case analyses formed the basis for the following articles:

(1) "Which Will It Be—Lower Income or Increased Efficiency?" Eastern States Cooperator, September 1949, a request for reprint from earlier article in Farm Economic Facts.

(2) "Adjustments to the Drought," Massachusetts Dairy Digest, August 1949.

(3) "Irrigation Possibilities," Farm Economic Facts, October 1949.

(4) "Can Massachusetts Dairymen Meet More Competition?" Massachusetts Dairy Digest, April 1950.

Reprinted in The Market Administrator's Review, Vol. 1, No. 5, June 1950.

## DEPARTMENT OF AGRICULTURAL ENGINEERING

H. N. Stapleton in Charge

### Forage Handling Investigations. (H. N. Stapleton and Earle F. Cox.)

*Barn Hay Drying.* Test work on high-volume fans using unheated air has been based upon using fans which would not require more than  $7\frac{1}{2}$  h.p. This test work has been continued using new installations at the University Farm and also using the plenum blast tunnel. In the barn installations, studies of air moisture relationship in the mow space, the hay, and the air distribution system have been made in an effort to develop a more accurate evaluation of evaporating capacity. Instrument readings last season indicated both a higher dry bulb and a higher dew point above the hay mass than in the main duct.

Tunnel testing with standard fans has shown that the fit of the fan blade to the mounting ring may change the air delivery as much as 10 percent with the same h.p. requirement. The optimum shape for the discharge tube is also being investigated, for in most installations length of the tube must be limited to one fan diameter. This work combined with studies of air moisture is expected to produce water evaporation ratings for the recommended fan selection for this service.

The "Jayhawk" Stacker which was obtained in an attempt to speed up the loading operation was not satisfactory as purchased. The 8-foot teeth were replaced with 5-foot teeth, but these still did not give satisfactory performance. As nearly as could be determined the friction developed when the juices caused the hay to adhere to the wooden teeth prevented the satisfactory pickup of hay.

**Air Conditioning of Animal and Crop Storages.** (H. N. Stapleton and Earle F. Cox.)

*Improvement of Poultry House Ventilation.* Several ventilating systems have been under test for the past winter.

1. Forced ventilation using a fan running continuously. A damper was installed to give either full recirculation or full exhaust. A damper motor was used to control the damper with a thermostat setting of 50°F. The maximum temperature differential in a well-insulated pen was 30° and the minimum was 10°. While it did help overcome the effect of sudden changes in outdoor temperature, this system was unsatisfactory because of excessive air change. Damp litter at the front of the house resulted, but the excess air did remove objectionable odors.

2. The same as No. 1 except that Thermopane windows, furnished by the manufacturer, were installed as condensing plates. Moisture removal was planned through condensation of the water on the windows with a partial gain of the heat of vaporization. A very mild season required the development of excessively high humidities within the structure on the available temperature differential, so that this method is not considered to have application in our climate.

3. The same as No. 1 except that two thicknesses of burlap were installed over the fan outlet and a damper was set so that there was a continuous air movement against the burlap. This resulted in approximately 5° higher temperature differential over that obtained by system No. 1. However, the relative humidity was very high and the system was not as satisfactory as No. 1.

4. This system made use of a ventilated space between the rafters, with one inch of fiber glass insulation installed under this ventilated space. No vapor seal was installed on the fiber glass. The purpose of this arrangement was to see whether vapor could be moved through the fiber glass without any great movement of air. The relative humidity was high in this installation.

5. This system made use of a control based upon differential dew point. Two recording instruments were used: one outdoors, and one inside the building. Under this control no air was exhausted unless the absolute humidity inside the pen was higher than it was out of doors. This arrangement is believed to be the best control for drying operations which has been developed to date. It is the only system which gives satisfactory results.

Litter samples were put through the bomb calorimeter and the heat value was determined at 7900 B.T.U. per pound. New instruments provided a measure of the vapor pressure at different places within the house. It was found that the vapor pressure was lower at the fan intake near the floor than at the floor in the front of the house or at the ceiling. In general the temperature at the fan intake was lower than at the ceiling and a 10° differential was frequently recorded.

*Improving Tobacco Curing.* This project so far has been carried with the help of cooperating farmers. Four installations were made and one additional installation was provided with a recording hygrothermograph. Three installations consisted of 2-blade propeller fans run at low speeds. The fans were installed near the peak of the barn with ductwork and a manually operated damper to permit exhausting air, recirculating air, or any intermediate setting. The operator set the damper according to his observations as the cure progressed. A fourth installation consisted of a Pierson-Moore crop drier. Heat was used for the first few days and then only the fan was used intermittently. Good curing resulted in all installations. Since the season was favorable for curing tobacco, the results obtained do not indicate what may be expected in a cold damp year. Two of the cooperators reported a more uniform cure in the sheds containing these systems than they had in adjacent sheds.

**Investigations on Mechanizing Cranberry Production.** (Earle F. Cox and F. B. Chandler.) A standard Allis Chalmers Model G. tractor has been obtained and modified for use on cranberry bogs. The two standard rear wheels were removed and replaced with a four-wheel drive, two wheels per side in tandem. This tractor weighs approximately 1500 pounds and develops 8 to 10 drawbar horsepower. The pressure exerted by the tires on the cranberry bog is less than that which would be provided by a man walking across the bog. A duster attachment for this tractor with a 20-foot boom is nearly complete, and a mist sprayer is in the process of development. Plans are being developed to provide attachments on this one tractor for dusting, spraying, pruning, raking, harvesting, ditch cleaning, mowing, and sanding, should sanding prove to be necessary.

**Cranberry Harvesting and Packing Investigations.** (Earle F. Cox and F. B. Chandler.) Investigations have been made of methods of treating berries at the time of harvesting and during packaging which would have no ill effects on berries. The berries which were given a water treatment before the final drying operation did not keep so well as those which were kept dry during the harvesting operation. The berries which were packaged in a cardboard container having a cellophane window were the best in keeping quality. Gas analysis studies are still in process to determine the effect on berries packaged in polyethylene containers. When the work is completed it will provide a comparison between kraft paper, cellophane, perforated cellophane, cardboard containers with cellophane windows, and the last four plus a treatment of propylene oxide applied at the time of packaging. Various wet and dry treatments, providing a total of 505 separate tests on the harvesting and packaging of berries, will be tabulated.

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## DEPARTMENT OF AGRONOMY

Dale H. Sieling in Charge

**Influence of Organic Matter on the Availability of Soil Phosphate to Plants.** (Dale H. Sieling and Joseph D. Dalton.) Ordinarily native soil phosphate or the phosphate added to soils as fertilizer is fixed in the soil by certain components in forms which are only slightly available to plants. Since acid soils are particularly effective in this fixing process, the efficiency of the phosphate added as fertilizer to these soils is very low. It has been determined that most of the phosphate fixed in acid soils is in the form of either basic iron- or aluminum-dihydrogen phosphate. Both of these chemical compounds have extremely low solubility and thus do not furnish adequate phosphate to crops growing in such soils. The quantity of both iron and aluminum in most soils of the northeastern part of the United States is so great that their capacity to fix phosphates is almost unlimited—at least from a practical standpoint.

Laboratory investigations have shown that certain organic acids are quite effective in preventing the fixation of phosphate by either iron or aluminum and that the most effective organic acids are those normally produced in considerable quantity in the soil by the action of microorganisms on plant residues. These observations suggest that the active decomposition of organic matter in soils produces substances which are effective in freeing fixed phosphate so that it may be utilized by growing plants.

Greenhouse pot experiments have shown that the cumulative yields and phosphate absorption of successive crops of Ladino clover were markedly affected by the addition of decomposable organic matter to the soil. Cultures to which corn-starch had been added at the rate of four tons per acre far outyielded all other cultures. Glucose and sucrose were less effective than starch but caused in.



creases in growth and phosphate uptake equal to or greater than did soluble phosphates at 80 pounds or 160 pounds per acre rates. These results indicate that the substances produced in soils by microbiological decomposition of organic matter are effective agents in making soil phosphates more available to plants.

**The Relative Capacity of Plant Species to Utilize Phosphorus from Aluminum and Iron Phosphates.** (Walter S. Eisenmenger and Clinton R. Blackmon.) The object of this experiment was to learn the relative capacity of plants of different degrees of development to utilize phosphorus of the relatively insoluble aluminum and iron phosphates.

The plants used, in approximate order of development, were cotton, rape, mustard, bean, clover, buckwheat, tomato, tobacco, and sunflower. Cotton represented the lowest in order of development, sunflower the highest. Each of these nine species of plants was grown in a set of four crocks containing phosphorus-deficient soil. To one, the control, nothing was added; to the other three, primary calcium phosphate, aluminum phosphate, and ferric phosphate, respectively, were added. Each of these 36 plantings was in triplicate.

As might be expected, percentage gain in dry weight was highest in plants grown in primary calcium phosphate. In decreasing order followed those grown in aluminum phosphate, ferric phosphate, and the control.

When the pH of the soil was 6.6 and aluminum phosphate was added, the average percentage gain of the aerial portion of mustard, rape, and cotton—the three least developed plants used—was more than eight times the gain of sunflower, tobacco, and tomato—the three most highly developed plants used. At the same pH, when ferric phosphate was added, the average percentage gain of the aerial parts of the same lower plants was more than ten times that of the three most highly developed plants.

The percentage gain in phosphorus per gram of oven-dried material was greatest in plants grown in soil to which primary calcium phosphate had been added. However, the total uptake of phosphorus was not greater for the less developed plants than for the more highly developed plants. This may have been due to the fact that plants of higher development were in most cases larger than those of lower development.

The behavior of the sunflower was exceptional. Unlike the other higher plants, sunflowers seemed to be able to utilize phosphorus from various sources as well as did some of the lower plants.

**The Absorption of Chemical Elements by Plants.** (Walter S. Eisenmenger and Karol J. Kucinski.) The addition to the soil of compounds containing "micro" elements may cause plants to increase the uptake from the soil of some of the major elements essential to plant growth.

To each of a series of seven plots was added a compound containing either zinc, copper, calcium, magnesium, manganese, chromium, or molybdenum. To the eighth plot, no compound was added. On each of the plots cabbage and Swiss chard were grown. Calcium, manganese, sodium, potassium, magnesium, and molybdenum were determined in the plants grown on each of the plots.

There was evidence that manganese increased the magnesium and calcium content of Swiss chard; but only sodium was increased by the addition of manganese to the soil where cabbage was grown. Chromium and zinc seemed to have no influence in increasing the other cations; calcium increased the uptake of calcium in both cabbage and Swiss chard; copper increased the potassium content of both plants; molybdenum compounds increased the amount of this element in plants; and manganese compound increased the manganese content, but the increment was smaller than in the case of molybdenum.

**Absorption of Chemical Elements by Plants.** (Walter S. Eisenmenger and Jean-Marie Lapensee.) It has been found that magnesium ions are taken up by plants in almost direct proportion to the ionic concentration of the soil except in soils where appreciable quantities of potassium ions are present. The presence of potassium apparently reduces the capacity of the plants to take up magnesium.

With this in mind, an experiment was planned to learn the relative availability of magnesium in six different soil series by analyzing the foliage of thirteen species of plants. The leaves were collected from uncultivated areas to which no fertilizer had been applied; most of them from forests. The plants chosen were white pine (*Pinus strobus*), poverty grass (*Andropogon scoparius*), birch (*Betula populifolia*), oak (*Quercus velutina*), chestnut (*Castanea sativa*), beech (*Fagus ferruginea*), poplar (*Populus tremuloides*), goldenrod (*Solidago nemorales*), ash (*Fraxinus americana*), grape (*Vitis riparia*), sumac (*Rhus typhina*), cherry (*Prunus pennsylvanicus*), and maple (*Acer rubrum*).

The soils chosen were Lenox, Worthington, Colrain, Blandford, Agawam, and Chicopee. Lenox soil is weathered from schist and limestone; Worthington soil from Conway schist, biotite, garnet, graphite mica schist, and some limestone; Colrain soil is similar to Worthington with some limestone drift and some sandstone; Blandford soil is weathered from Conway schist, sericillite, garnet, and chlorite; Agawam soil, from mica schist and granite; and Chicopee soil from triassic sandstone and shale.

The leaves of all plants were analyzed for calcium, magnesium, potassium; sodium, phosphorus, and sulphur. The leaves highest in calcium, magnesium, and sodium were those grown in Colrain, Worthington, and Lenox, all of which are weathered from schist and limestone. The potassium content was almost in reverse order. The leaves grown on Blandford soil contained the most potassium, followed in decreasing amounts by those on Worthington, Lenox, Colrain, Agawam, and Chicopee. Plants grown upon Agawam and Chicopee soils absorbed smaller amounts of cations than the same plants absorbed from the other soils studied. Alluvial soils may furnish fewer cations than soils recently weathered from primary rock. Phosphorus, for the most part, was higher in percentage in localities where the magnesium was high. High base exchange of magnesium, calcium, and potassium did not in every case correspond with the high percentage intake by plants. More magnesium was taken up by plants growing upon soils of high pH than by the same plants growing on soils of lower pH.

**Field Tests with Magnesium.** (Karol J. Kucinski.) It has been felt for some time that certain farming areas, although not showing malignant symptoms of magnesium deficiency on the foliage of plants grown on them, may yet be lacking magnesium for normal growth and maximum crop yield. In order to demonstrate this contention, a series of farm field trials were made in cooperation with several farmers, using various field crops grown on different soils. Because of the abnormally dry growing season the increases in yield on fields where magnesium was applied were not so large as those obtained the preceding year (1948). As much as 26 percent increase in the yield of potatoes was noted where 200 pounds per acre of Epsom salts were applied. An increase of 10 to 43 percent in yield of hay and 3 to 6 percent in yield of onions was obtained with the same treatment. As a result of these tests and similar demonstrations at other stations, soluble forms of magnesium are being used in the formulation of certain commercial fertilizers. Some fertilizer manufacturers guarantee soluble magnesium in all their grades for the 1950 season. It is recommended that 30 to 40 pounds of magnesium oxide in soluble form be added per ton of commercial fertilizer which

is to be used for growing vegetables or field crops on alluvial or glacial outwash soils.

**Irrigation Studies and Management of Irrigated Soils.** (Karol J. Kucinski, Herbert N. Stapleton, and Dale H. Sieling.) The abnormally dry growing season (1949) has caused considerable interest in portable irrigation systems by tobacco, truck, and dairy farmers of Massachusetts. Studies are being made to investigate all phases of supplemental irrigation as it applies to various kinds of crops, fertilization, changes in soil structure, and effect on diseases and pest control, as well as to yield and quality of product.

Experimental irrigation plots for tobacco, potatoes, onions, cabbage, and millet have been laid out along the Connecticut River. The dry growing season favored yield data obtained from the irrigated plots. Results with set onions showed that without irrigation three-fourths of the area would have been a failure and only half a normal yield would have been harvested on the remaining area. Japanese millet averaged 82 percent increase in yield with four applications of water totaling  $3\frac{1}{2}$  inches. The irrigated millet showed about 25 percent increase in germination over the check plot. Irrigated late cabbage yielded 130 percent more than the check, while potato yields increased 16 percent with irrigation. Anhydrous liquid ammonia injected into the system at the time of irrigating a mixed-grass rowen caused an increase in yield of over 100 percent. Application of plant nutrients using the irrigation system will be further investigated. Soil moisture studies, using tensiometers and plaster of Paris moisture blocks, are being made.

A survey was conducted of all the research activities pertaining to supplemental irrigation in the Northeastern States and a report of the survey was made to the Northeastern Soil Research Committee.

**Tobacco Yields as Related to Preceding Crop.** (Walter S. Eisenmenger and Karol J. Kucinski.) Attempts were made to learn the reasons for the difference in yield and quality of tobacco when various types of plants had been grown on the land during the previous season. The amounts of ceric sulfate and hypoidite required to oxidize the soil, percentage loss on ignition, lignin content of the preceding crop, and aggregates of soil larger than 4 mm. were used to measure the relative rate of decomposition of plant residues from the various types of plants grown. The plants used for this work were Jerusalem artichoke, sunflower, horseweed, oats, wheat, rye, corn, kaffir, Sudan grass, milo-maize, tobacco, squash, buckwheat, and rape.

Under the conditions of this experiment, the crops which, in rotation with tobacco, usually produced favorable yields of tobacco were those with the most rapid rate of decomposition as determined by the above-mentioned tests. Jerusalem artichokes and sunflowers seemed to produce more organic matter than perhaps any other one species of plants used; but the material from these species decomposed more rapidly in the soil than did that from species of the grass family. The yield and quality of the tobacco crop were better when it followed tobacco, sunflowers, or Jerusalem artichokes than when it followed rye, wheat, corn, Sudan grass, or kaffir.

**Use of Process Tankage in Tobacco Fertilizer.** (Karol J. Kucinski and Dale H. Sieling.) It is the object of this study to determine whether "Wamco," a processed tankage made from leather scraps in the eastern part of Massachusetts, can be used in the formulation of tobacco fertilizer. Results of fertilizer experiments with shade-grown tobacco, where the organic nitrogen from "Wamco" was substituted for the usual cottonseed meal, showed very little difference



in quality. The percentage of "off-color" tobacco was a little higher on the plots where tankage was used. Trials with "out-door Havana Seed" tobacco showed that where half the organic nitrogen was replaced with "Wamco" tankage the yield and quality were not significantly different from those where all of the organic nitrogen was from cottonseed meal; but where all of the organic nitrogen was replaced by "Wamco" the yield and quality were slightly inferior. If the quality and yield of tobacco is not significantly impaired by the use of "Wamco" process tankage, then a local source of organic nitrogen will be made available to the tobacco grower of the Connecticut River Valley. The saving in cost by not having to transport cottonseed meal from the South would amount to a substantial sum.

**Fertilization of Tobacco Seedbeds.** (C. V. Kightlinger.) Good seedbeds are necessary for the successful production of tobacco. Proper fertilization is one of the most important factors in the production of good tobacco seedbeds. Important features are the time of fertilization, the kinds of fertilizer used, and the rates and ways the fertilizers are applied.

A series of seedbed plots was fertilized with tobacco fertilizer (6-4-7) in the fall at the rates of 68, 92, 115, and 138 pounds per 1000 square feet of seedbed space; other plots were fertilized in the spring with the same kind of fertilizer at the same rates of application. These treatments were duplicated in another series of plots, except that inorganic fertilizer (7-7-7) was used.

The soil had been plowed at the end of the previous seedbed season and disk harrowed occasionally during the summer. The fertilizers were applied to the fall plots in September, and the whole seedbed was rototilled to a depth of approximately four inches to mix the fertilizers into the soil of the fertilized plots and to prepare the whole area for sterilization. The whole seedbed space was then treated with chloropicrin. In the spring the fertilizers were applied to the spring plots and the entire seedbed space was rototilled as before. Next day (April 20) all plots were seeded with the same kind and amount of seed and watered lightly to cover the seeds.

The germination of seed was good in all fall-fertilized plots, regardless of kind and amount of fertilizers used, except in the plot fertilized with inorganic fertilizer at the rate of 138 pounds, where the stand of seedlings was rather thin, and the subsequent growth of plants was squatty. Germination was somewhat better in the plot fertilized with organic fertilizer at the rate of 68 pounds than in the other plots, but growth was somewhat slower than in the plots fertilized with organic fertilizer at the rates of 92 and 115 pounds. The growth of plants in these latter two plots was the best of the experiment. Growth was noticeably better in all plots fertilized with organic fertilizer in the fall than in corresponding plots fertilized with inorganic fertilizer at the same time.

The germination of seed in all plots fertilized in the fall was better than in the corresponding plots fertilized in the spring, regardless of kind and amount of fertilizer used. It became progressively poorer in all spring-fertilized plots as the rates of fertilization were increased; but was always better in the plots fertilized with organic fertilizer than in the corresponding plots fertilized with inorganic fertilizer. There was almost no germination of seed in the plot fertilized with inorganic fertilizer at the rate of 138 pounds. What seedlings there were in the spring-fertilized plots grew somewhat better in the plots fertilized with organic fertilizer than in those fertilized with inorganic fertilizer.

The results of these experiments show that fall fertilization is much better than spring fertilization of tobacco seedbeds, and that organic fertilizer is superior

to inorganic fertilizer for the purpose. Tobacco fertilizer applied in the fall at the rates of 92 or 115 pounds supplied all the plant food needed to grow good tobacco plants, and there was no need to apply any additional fertilizer in the spring before seeding.

**The Improvement of Havana Seed Tobacco.** (C. V. Kightlinger.) It is the purpose of this project to improve Havana Seed tobacco and its production in the Connecticut Valley by breeding new strains which combine high resistance to black root rot, common tobacco mosaic, and wildfire with habits of growth and yielding capacity acceptable to farmers and type and quality that are acceptable to manufacturers of cigars.

The breeding program has already met with considerable success. Strains have been produced which are highly resistant to black root rot, have good habits of growth and yielding capacity, and have excellent type and quality. At least 90 percent of the acreage of Havana Seed tobacco in the Connecticut Valley is now planted to some of the improved strains. Their use has contributed to increased yields per acre as well as improvement in quality, which together have resulted in greater profits to growers.

Breeding work is being continued in the hope of making still further improvement in disease resistance, yield, and quality. Particularly, efforts are being made to breed resistance to mosaic and wildfire into some of the strains already produced.

**Tests of Spray Materials for the Control of Late Blight of Potatoes.** (C. V. Kightlinger and H. M. Yegian.) Numerous new fungicides for the control of late blight of potatoes have been introduced during the last few years. Some of these materials are used extensively by potato growers, give acceptable control of late blight under light to moderate incidence of the disease, are convenient to use, and have little or no harmful effect on potato foliage. However, it is not known how well they might control the disease during years of greater incidence. It was principally to get information on this point that the work was continued this past year. Dithane 14, Dithane Z78, and yellow cuprocide were tested in comparison with Bordeaux 5-2½-50. However, since the incidence of late blight was light in 1949, no information was obtained as to the value of these materials when the disease is severe.

**Potato Variety Trials**—(Karol J. Kucinski and Ralph W. Donaldson.) Twenty-seven different varieties or strains of potatoes were grown and compared for yield, habit of growth, and resistance to diseases. The eight highest yielding varieties ranging from 439 to 312 bushels per acre were, in descending order, Katahdin, Essex, Cobblers, Bliss Triumph, Chippewa, Pontiac, Erie, and Ontario. Green Mountains ranked twenty-fifth. The drought during the 1949 growing season seriously affected this late variety. The three lowest yielding varieties, ranging from 227 to 172 bushels per acre, were Cayuga, Pawnee, and Narkota. Most of the farmers are growing the high yielding varieties.

**Breeding Work with Orchard Grass** (W. G. Colby.) Additional plant selections were made from space-planted nurseries of the Finnish late hay strain of orchard grass. Some very late maturing plants have been isolated which are fully a month later than commercial orchard grass. The practical value of these very late maturing plants is doubtful, since extreme lateness is apparently secured at the expense of vigor and productivity.

Field trials with our strain of Finnish late hay continue to give good results. One stand entering its third grazing season still has some Ladino clover present and is still being grazed satisfactorily by cows.

**The Relationship of Nitrogen Fertilization to Yields and Leafiness of Orchard Grass.** (W. G. Colby.) An area seeded to Finnish late hay orchard grass in the summer of 1947 was laid off in plots with differential nitrogen fertilization treatments with initial applications made in the spring of 1948. A very close correlation was obtained between the rate of nitrogen application and the degree of leafiness and also yield of this strain of orchard grass. At low nitrogen levels few leaves were produced and yields were very low; at medium nitrogen levels (30 pounds of elemental N applied in early spring) more leaves developed and yields were fair; at high nitrogen levels (60 pounds of elemental N) all plants were quite leafy and hay yields were high.

The results of this experiment may explain the poor performance of this strain secured by some other investigators. Where nitrogen levels are low, Finnish late hay orchard grass looks and yields poorly when compared with vigorous early maturing strains. Where nitrogen levels are high, this strain will compare favorably with the early maturing strains in yield of total dry matter and, in addition, will produce a much leafier, better quality forage.

**Trials with Cutting, Management, and Nitrogen Fertilization of Timothy.** (W. G. Colby.) In last year's report (Mass. Agr. Exp. Sta. Bul. 453: 11-12) favorable results were reported from the liberal use of nitrogen fertilizers on timothy hay sods in late fall or early spring, followed by early cutting (pre-bloom stage), as a means of reducing lodging losses. Good yields (3600 pounds per acre) of high quality hay were produced with no tendency to lodge. Thus far the results were favorable. Subsequent results, however, were unfavorable. The months of July and August in 1949 were abnormally hot and dry. The early-cut plots (June 10) were severely injured. In several instances the stand of timothy was practically lost, with Kentucky blue grass taking its place. The late-cut plots (June 20) while injured by the hot, dry weather, still maintained a fair stand of timothy. If timothy stands are to be maintained, continued early cutting (prior to full-bloom stage) is not recommended. The application of nitrogen after the first crop of hay cut at full-bloom stage had been removed, had no adverse effect on the stand of grass. This method of using larger amounts of nitrogen fertilizer on grass hayland can be followed without encountering serious difficulties.

**Onion Breeding.** (Hrant M. Yegian.) During the 1949 season, about 80 lots of *Allium cepa* and *Allium porrum*, introduced from Turkey by Mr. J. H. Harlan, were tested. The more promising varieties among the lot were selected for future breeding purposes.

The uniform field test of experimental hybrid onions, set type, was not very successful. Lack of adequate moisture and high temperature during the growing season made it impossible to secure comparative data on the relative performance of different crosses. Some of the inbred lines, with reduced vigor as a result of repeated inbreeding, completely failed to produce any seed under these unfavorable weather conditions. Very few crosses were effected between male-sterile and normal inbred lines for future testing.

Machines are now available on the market for setting onion transplants. Preliminary tests with transplants between male-sterile and sweet Spanish crosses are being carried on in order to find a hybrid best adapted to this locality.

**The Evaluation and Use of Flint Lines in Flint-Dent Corn Hybrids.** (Hrant M. Yegian.) During the 1949 season, 75 double crosses from the uniform tests of single crosses set up by the Northeastern Corn Improvement Conference were tested. These crosses ranged from early to midseason in order of maturity.



Among them there were few crosses superior in performance to Mass. 62. One of the flint-dent crosses was as early as Maine B. It had a lower percentage of broken stalks and produced more corn per acre than Maine B. The double crosses with best performance are being tested further, preliminary to recommendation for commercial production of the hybrid seed.

Forty-five all-combination single crosses of the U.S. 13 maturity group and another set of 45 single crosses of the Mass. 62 maturity group were tested for performance with respect to various agronomic characters in order to evaluate the selected inbred lines for specific combining ability. Predictions of the performance of all possible double crosses are made on the basis of the data obtained on the performance of the single crosses.

A new set of 45 all-combination single crosses involving 10 flint and dent lines were made with the objective of finding an early maturing flint-dent hybrid.

Development of inbred lines from open-pollinated varieties by selection within self-fertilized lines was continued. A mutant line was isolated containing 35.5 percent total sugar or dextrose in the cornstalks, on a moisture-free basis. Possible use of this line in the production of hybrid ensilage corn will be investigated.

#### **Conservation Projects. (Karol J. Kucinski.)**

*Fertilization of Beach Grass.*—Beach grass plots at Sagamore, Mass., to which commercial fertilizer was applied at various rates during the fall of 1948 showed a definite response to treatment, but not as great as when fertilizer was applied during early spring. Nurserymen dealing with stabilization of coastal sand dunes around airports and coastal resort areas are interested in producing and increasing nursery stock of beach grass transplants. Fertilization of beach grass has increased the quantity and quality of transplants.

*Winter Cover Crops for Onions.*—The common practice of plowing onion fields in the fall and leaving them bare during the late fall and winter months has, at times, created conditions favorable for the occurrence of dust storms and wind erosion when there is no snow cover. Last fall, blue lupine, barley, and winter rye were sown on onion fields to serve as winter cover crops. In the spring, these fields were plowed. The cover crops were completely buried and no difficulties were experienced in fitting the fields for the planting of onions. The farmers who cooperated in this demonstration were satisfied that it is possible to use winter cover crops on onion fields to protect them against wind erosion and also increase the much needed organic matter in the soil.

*Farm Fish Ponds.*—Farm fish ponds are a new venture in this region and very little is known about the yield and rates of growth of self-propagating fish in farm ponds which are fertilized. Ponds are being constructed at the Experiment Station for study of the various phases of the subject, and additional ponds with private ownership are being used to enlarge the scope of the study. The management, maintenance, and cost of construction of various types of farm fish ponds has been investigated. Depending on local conditions, farm ponds can be built at a cost ranging from \$150 to \$1000 and averaging \$300 to \$400. Stocked fingerling trout grew in one season to about 10 inches in length while black bass grew to 11½ inches in ponds fertilized with 7-7-7 grade commercial fertilizer. A plankton "bloom" comparable to that in southern states was obtained last season with the use of commercial fertilizer. Successful construction of farm ponds will provide water for fire protection, irrigation, farm stock and crop spraying recreation, and will reduce fishing pressure on streams and lakes.

*Ever-Ready Water Hole.* Valuable farm buildings are often destroyed by fire in the winter in spite of the fact that plenty of water could be made available from ponds or near-by rivers, were they not frozen over. The length of time firemen



**"Ever-Ready Hole" In Frozen Farm Pond Aids Winter Fire-Fighting.**

need to chop a hole through thick ice after they reach a fire may be a deciding factor in saving a homestead or other farm buildings. A simple "ever-ready hole" that will save valuable minutes when the fire fighting apparatus arrives is shown in the accompanying photograph.

An oak barrel, such as a cider barrel with one end knocked out, is partially filled with a brine solution. The barrel should be floated near the bank in a deep part of a farm pond or stream which can be easily approached by a fire truck. An approach, such as a plank supported on posts, can be made to reach out to the barrel which is anchored with a piece of board to the approach. The barrel may be covered so that small animals will not fall in, and so that rain water will not dilute the brine solution. The exact location of the barrel can be marked by nailing an upright stick to the side of the barrel and having it extend a few feet into the air. This marker will be readily noticed if snow covers the surface of the site.

In case of fire, a fireman with an axe needs only to strike the wooden staves of the barrel about four times and the barrel will crumble, leaving a hole in the thick ice through which the suction pipe can be dropped into the water. During the past two winters, tests were made with such an "ever-ready hole," and it was found that it took about 16 seconds to break up the barrel with four good blows on the staves with an axe.

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#### DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

Because of the absence of the project leader on sabbatical leave from September 1949 to April 1950, research work in this department has been relatively inactive.

**A Study of the Mineral Elements of Cow's Milk.** (J. G. Archibald.) No work was done on this project during the year for the reason noted above.

**A Study of Quality in Roughage: Composition, Palatability, and Nutritive Value of Hays as Affected by Curing, Harvesting, and Storing Procedures.**

(J. G. Archibald and M. L. Blaisdell.) Field work on this project was continued for the third season in the summer of 1949. Ten lots of hay were involved, representing field curing and barn drying, both baled and loose. Samples of the several lots were taken at cutting time, at loading time, at intervals of three days, a week, and a month in storage, and when fed out. A total of 57 samples was obtained and analyzed for moisture, carotene and sugar, in addition to the conventional fodder analyses. Combined with 51 samples from the 1947 hay crop and 84 from the 1948 crop, the results from all three seasons are now being correlated, interpreted, and prepared for publication. Final conclusions are not yet available, but the results for 1949, insofar as they have been studied, appear to confirm the tentative conclusions published at considerable length in last year's report. A feeding trial with eight cows, similar to the one conducted in the winter of 1948-49 and reported last year was conducted during the winter of 1949-50. Results show no significant difference for milk production between lots of hay from the same field, whether field cured or mow cured.

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### DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

**Bacteriological Studies of Sewage Sludge.** (James E. Fuller.) This project has been reported previously (Mass. Agr. Expt. Sta. Buls. 449, 1948, and 453, 1949). A publication on the work of this project will appear in the July 1950 number of "Sewage and Industrial Wastes."

**Survival of *Escherichia coli* from Sewage in Soil of Septic-tank Disposal Fields.** (James E. Fuller.) The purpose of this project was to determine the extent of penetration of *E. coli* into the soil surrounding septic-tank disposal fields, and the survival of the organism in that environment. A progress report has been made previously (Mass. Agr. Expt. Sta. Bul. 453, p. 18, 1949). Results to date indicate that *E. coli* did not penetrate the soil of the fields studied to any considerable extent, nor survive when inoculated into the soils. That the sewage effluent penetrated the soil to distances substantially greater than the penetration by *E. coli* was shown by two procedures: (1) The use of an indicator, fluorescein, which was added to the septic-tank effluents. (2) The greater sodium-chloride content of the soil adjacent to the disposal lines as compared to that of near-by soil which received no effluent.

The result of this study poses the question of how reliable a laboratory test for *E. Coli* may be as an indicator of safety from pathogenic sewage borne micro-organisms. This applies particularly to the testing of water from wells or springs that may be located near septic-tank disposal fields. A positive *E. coli* test would indicate a source of sewage pollution, but a negative test might be misleading. Probably it would indicate safety from such bacteria as those which cause typhoid fever or bacillary dysentery. However, there may be other dangers. It has been shown, for instance, that the virus of poliomyelitis may be present in sewage; but it is not known how far it may penetrate through soil, or survive in it. Two other possible dangers in a similar category are amoebic dysentery and hookworm in regions where these diseases are prevalent.

**Effect of Surface-active Agents on Bacteriological Activity in Septic Tanks.** (James E. Fuller.) This study was undertaken to accumulate information so that intelligent answers can be given to inquiries that come to this laboratory concerning the possibility that the increasing household use of these soap substitutes may cause septic tanks to function improperly, or fail completely and be-



come clogged. To date 23 surface-active agents (detergents) have been examined. These are distributed among the common chemical groups into which most of the household detergents on the market may be classified. A few of the agents tested have disinfecting as well as cleansing properties. Samples have been set up in 2-quart fruit jars at laboratory room temperature, and tests have been made for ammonia and nitrate nitrogen, hydrogen-sulfide production, settleable solids, total bacteria counts, and numbers of coliform bacteria. Results to date indicate that concentrations of the agents likely to be present in sewage at any given time have no detrimental effect on bacterial activity in septic tanks. On the contrary, a few of the agents seem to increase the numbers and activities of the bacteria.

**Types of Organisms Involved in the Spoilage of Home-canned Foods.** (John M. Dickerman.) There is considerable loss in home-canning due to inadequate sterilization and defective containers. Estimates of this loss vary from 2 to 10 percent. In the case of inadequate sterilization, heat-resistant bacteria, particularly spore-formers, are the causative agents of the spoilage. Where defective containers are used, spoilage may be caused by a variety of yeasts, molds, and bacteria, which gain access to the jar after sterilization. A knowledge of the types of organisms causing spoilage should provide information as to their source and control.

Specimens of spoiled home-canned foods are obtained, through the cooperation of the Food Technology Department and the Agricultural Extension Service, and examined by standard and special procedures. Viable organisms are isolated. Eventually these organisms will be identified and thermal death rates determined. With such information at hand, it may be possible for those engaged in the teaching of home-canning procedures to re-evaluate the methods now being taught.

At the present time, samples of spoiled corn, green beans, peas, peaches, pickles, and tomatoes are under investigation. The organisms causing spoilage in most of these samples have been admitted to the contents by defective containers or the lack of a proper jar seal after processing. Various types of yeasts, molds, and bacteria, alone or in a variety of combinations, have been isolated and grouped according to their morphology, temperature requirements, and oxygen requirements. Standard and special procedures are being used in an attempt to identify the genus and species of these isolated microorganisms.

The results of these experiments are not as yet significant because of the lack of sufficient samples to give an over-all picture of spoilage in Massachusetts. However, it is felt that a continuation of this project will yield statistically significant data.

**Ozone as a Sterilizing Agent for Rural Water Supplies and Dairy Equipment.** (John M. Dickerman.) Ozone, maintained at a concentration of 2 p.p.m., has been used to clarify and purify some large municipal water supplies in this country. The use of ozone has gained wide acceptance in Europe for the treatment of water. However, until recently, the generation of ozone has been too expensive to permit its use for the purification of rural water supplies. In a series of limited experiments by others, it has been shown that ozone tends to destroy or eliminate bacteria, algae, tastes, odors, color, and organic matter from water.

The following project is under investigation to test ozone in a known amount as a sterilizing agent for rural water supplies and dairy equipment.

- (1) The action, under controlled conditions, of ozone on a variety of bacteria and algae encountered in rural water supplies and dairy equipment.

- (2) The ability of ozone to destroy or remove taste, odors, colors, and organic matter from rural water.

(3) The effect of ozonated water for the cleansing of dairy equipment and quarters.

The accepted method for the determination of ozone could not be used for this project because it involves the release of free iodine from a potassium iodide solution by the action of ozone. Free iodine has a marked germicidal effect upon bacteria. Therefore, if this method were used to determine the ozone concentration in a solution containing bacteria, no accurate measurement could be made of the germicidal action of the ozone because of the added germicidal effect of the free iodine. For this reason, a new test for ozone has been devised which uses the oxidization of a dye to the leucobase. By the new method, the amount of ozone can be measured colorimetrically and the test organism is not killed by the dye.

The effect of ozone on a variety of bacteria found in rural water supplies has been studied. Depending upon the organism that was used, 50 to 80 percent of the original number were destroyed by a concentration of 1 p.p.m. of ozone maintained over a five-minute period. However, the intimate dispersion of ozone which is necessary to give the maximum germicidal effect could not be produced in the apparatus that was used for these tests. Therefore, a new type of apparatus has been designed which it is hoped will maintain any desired concentration while producing a good dispersion of ozone.

Data secured to date are not sufficient to be significant and will not be reported here in detail.

**The Production of Marketable Organic Chemicals by the Microbic Decomposition of Wood Wastes.** (John M. Dickerman.) For a number of years, people have considered employing the microbiological decomposition of wood wastes to produce organic chemicals. Organisms have been studied that utilize cellulose, which is a main constituent of wood. The yield of any marketable organic product has been low. However, experiments of this type have been of such a limited nature that the various factors involved have never been thoroughly understood.

The purpose of this project is to study the microbiological decomposition of wood cellulose in an effort to isolate organisms that will do the work most effectively. An attempt will be made to develop conditions of culturing that will result in yields of organic products in quantities that will be profitable commercially.

This project is in the beginning stages and the data thus far accumulated are not sufficient to justify a detailed report.

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#### DEPARTMENT OF BOTANY Theodore T. Kozlowski in Charge

**Diseases of Plants Caused by Soil-infesting Organisms, with Particular Attention to Control Measures.** (W. L. Doran.) To learn more about how the control of clubroot of cabbage by hydrated lime and mercurous chloride, used together, is affected by the soil, a loam was modified by the addition of sand in different proportions. With clubroot severe in all untreated soils, there was no clubroot with mercurous chloride and hydrated lime in loam-sand 1:1 or 1:2, but 30 percent of the plants had clubroot in loam alone. It appeared that clubroot was more readily controlled by mercurous chloride and hydrated lime in a more sandy than in a less sandy soil.

The disease was better controlled by mercurous chloride 0.3 gm. per square foot than by 0.2 gm.

Growth of cabbage plants was retarded by mercurous chloride 0.3 gm. per square foot for 49 days after seeding in sandier soils, for only 35 days after seed-

ing in the less sandy soils. Growth was not retarded thereafter by mercurous chloride in any soil. Growth of plants 97 days after seeding, with clubroot interfering with growth in untreated soils, was much improved by mercurous chloride and hydrated lime in all soils, with most improvement in growth in the sandiest soils.

Ground limestone and hydrated lime were compared for use with and without mercurous chloride in the control of clubroot. There was partial but poor control of the disease by hydrated lime alone; no control whatever by ground limestone alone when both were applied immediately before seeding. First visible infection was more delayed by hydrated lime used alone than by ground limestone used alone. With 100 percent severe infection in untreated soil, there was no clubroot in soil treated with ground limestone 5600 pounds and mercurous chloride or mercuric chloride 33 pounds per acre. It is concluded that under some conditions ground limestone may be successfully substituted for hydrated lime for use with mercuric or mercurous chloride in control of clubroot.

Considerable time was devoted to writing a new Experiment Station Bulletin (No. 455) on "The Control of Some Soil-borne Diseases of Plants by Fungicides Applied in Fertilizer to Soil." It contains the conclusions reached in work under this project on the control of clubroot up to the time of its preparation.

A material, the active ingredient of which is 8 hydroxy quinoline benzoate (2.5 percent), was diluted 1:100 and 2:100 with water and applied to soil before seeding and again when seedlings emerged. It failed to control damping-off, which disease was well controlled by formaldehyde.

**Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment.** (W. L. Doran.) Phygon (50 percent 2, 3-dichloro-1, 4 naphthoquinone) is the most promising of the fungicides which have so far been used here, either alone or in combination with a root-inducing substance, for the treatment of cuttings of woody plants. Just how this fungicide may be most effectively and safely used with different species is now under investigation, and typical results are summarized below.

Cuttings were given powder-dip treatments with Phygon, usually diluted with talc or with Hormodin No. 1, No. 2, or No. 3. In some cases, such treatments were preceded by the treatment of the cuttings with a root-inducing substance, usually indolebutyric acid, applied by the solution-immersion method.

As compared with untreated cuttings, the percentages of fall and winter cuttings of hemlock, *Tsuga canadensis*, rooting were more increased by Phygon or by Phygon-talc (1:1 or 1:4, by weight in all cases) preceded by solution-immersion treatment with indolebutyric acid than they were by indolebutyric acid thus used alone.

Cuttings of red cedar, *Juniperus virginiana*, rooted in larger percentages after solution-immersion treatment with indolebutyric acid followed by powder-dip treatment with Phygon-talc, 1:4, than they did after treatment with indolebutyric acid used alone.

Cuttings of sweet bay, *Magnolia virginiana*, rooted in larger percentages after powder-dip treatment with Phygon-talc, 1:2, following solution-immersion treatment with indolebutyric acid than they did after treatment with indolebutyric acid alone.

The percentages of cuttings of *Franklinia alabamaha* and of *Rhododendron myrtifolium* which rooted were more increased by powder-dip treatment with Phygon-Hormodin No. 3 (1:4) than by Hormodin No. 3 used alone.

Cuttings of blackalder, *Ilex verticillata*, rooted in larger percentages after



treatment with Phygon-Hormodin No. 2 (1:1) than after treatment with Hormodin No. 2 used alone.

Leaf-bud cuttings of *Rhododendron catawbiense* rooted better after treatment with Phygon-talc, 1:2, than without treatment. Rooting of cuttings of *Colony-easter horizontalis* was improved by Phygon applied alone as a powder-dio.

A paper on "The vegetative propagation of a few species of elm" by William L. Doran and Malcolm A. McKenzie was published in the *Journal of Forestry* 47:10, pp.810-812, 1949. It includes a description of the propagation of a disease-resistant elm by root cuttings, a method developed here.

**Tobacco Frencing.** (L. H. Jones.) While it has been demonstrated and previously reported that a relatively high soil temperature, probably ranging from above to slightly below 32°C., is necessary to induce frencing of tobacco, it has never been demonstrated that the frencing factor must also be present in the soil. Until more is known of the exact nature of this frencing factor, the investigational work must continue to be exploratory and based upon the technique that the symptoms of frencing may be made to appear and be controllable at will by the soil temperature procedure.

Five soils were tested for the frencing factor and, of these, only two were found to be positive. Both of these soils were obtained from moist areas, one near a drainage ditch and the other by a pond. The former produced frencing symptoms in eight days while the latter needed only seven days. The three negative soils were from well-drained areas. However, when a frencing soil was mixed in small quantity with the nonfrencing soils, frencing symptoms were obtained. These tests demonstrated that the negative soils did not contain a naturally anti-frencing factor. On the other hand, when frencing soils are heat-treated with steam under pressure, the frencing factor is destroyed or subdued for the first planting of tobacco. Sometimes the second planting of tobacco was affected with frencing symptoms if the soil was not again steam-treated.

It is becoming apparent that the cause of frencing of tobacco may also affect other plants not closely related to tobacco, but the same environment of a high soil temperature must be present. Certain chlorotic conditions accompanied sometimes with leaf deformities have been noted on ragweed (*Ambrosiaartemisiifolia* L.), oxalis (*Oxalis stricta* L.) and winter squash (*Cucurbita maxima*). These symptoms were induced by maintaining a relatively high soil temperature in a frencing soil and were controllable at will by the soil temperature technique. The squash leaf with its palmate venation had the chlorotic symptoms limited to the border of the leaf. When the above-mentioned plants were grown at a soil temperature of 21°C. or in autoclaved soil at 35°C., the chlorosis was absent. The reaction of these plants corresponds perfectly with the reaction of tobacco grown in frencing soils.

It has been possible to demonstrate that true frencing is not a nitrogen-deficiency reaction by applying nitrogenous compounds to the soil or by spraying the plants with the nitrogen-containing substance, Nu Green. Known nitrogen-deficient plants responded to either by gradually becoming greener and resuming normal growth. True frencing, induced by a high soil temperature, was not alleviated either by the application of nitrogen to the soil or by the spray treatment. On the other hand, there is some evidence that a dilute spray of ferrous sulfate does cause greening of chlorotic leaves under conditions of true frencing. Further tests are necessary to develop this diagnostic technique.

Cuttings made from frenced and nonfrenced plants rooted well in sand and, when potted into a nonfrencing soil, developed normal plants. This substantiates and further proves the point that the frencing factor is not carried by the

plant and is not reproduced within the plant. However, the cuttings of both frenched and nonfrenched plants did resume and acquire frenching symptoms when placed in a frenching soil at a 35°C. soil temperature, but produced normal plants when grown in autoclaved soil at 35°C. or grown at a soil temperature of 21°C.

*Chemical Soil Fumigant Temporarily Controls Frenching Factor.* (L. H. Jones and L. H. Weinstein) In a preliminary test with a volatile soil fumigant, its effectiveness in preventing frenching was equal to that of pressure-steaming the soil. The soil was known to contain the frenching factor and, after treatment with chemical or steam, was maintained at a soil temperature of 35°C. Plants of Havana Seed tobacco were set in the treated soil as well as in untreated soil which served as a check. The plants in the treated soil showed a marked stimulation in growth, especially those grown in the soil treated with the chemical. The check plants developed the various symptoms that are characteristic of frenching, but the plants in the treated soil did not give any evidence of frenching through the 59 days of the tests. All plants eventually were cut off close to the ground level, and a new set of plants replaced them. This second set of plants frenched in nine days in each of the soils originally treated with the chemical or steam, and the frenching symptoms became very intense as time went on. As yet there is no explanation for the effectiveness of the chemical and steam treatments in eliminating frenching symptoms from the first planting and the complete failure to prevent the frenching in the second planting.

*Transmission of Frenching Symptoms from a Frenched Plant to a Healthy Plant.* (L. H. Jones and W. H. Weinstein.) There is no previous record that it has been possible to transmit the symptoms of frenching from a frenched plant to a healthy plant. By growing two sets of three tobacco plants each in two containers placed in two adjacent water baths at a temperature of 21°C., it was possible to bring one plant in one container sufficiently close to one plant in the other container to perform an inarched graft. The remaining two plants in each container served as check plants.

After 14 days from making the graft, the soil temperature in one container was raised from 21°C. to 35°C. to induce frenching. On the sixth day, frenching symptoms appeared on the checks and the grafted plant in the high soil temperature container. On the eighth day, the first symptoms of frenching appeared on the grafted plant at the 21°C. soil temperature. No frenching symptoms were apparent or ever appeared on the check plants at the lower soil temperature. As time went on and more leaves developed on the grafted plant at the lower temperature, the frenching symptoms became more intense, except that the second and fifth leaves above the first frenched leaf never showed any symptoms of frenching. These leaves were on the opposite side of the stem from the grafted side. At the conclusion of the experiment, these two leaves were larger than either of the leaves above or below them. Other observations include the less intense symptoms of frenching on the low-temperature plant. The pinhead chlorosis was common to both plants, but the low temperature plant, while producing smaller and narrower leaves than normal plants, did not produce the strap- or string-leaf forms which were present on the high-temperature plant. Terminal growth seemed but slightly retarded on the grafted plant at the low temperature when it had apparently ceased on the high-temperature plant. Axilshoots on the high-temperature plant were stimulated into growth 22 days after the temperature was raised, but did not start on the low temperature plant until the 35th day. Axillary shoots developed on the check frenched plants at the high

temperature, but none developed on the check and nonfrenched plants at the low temperature. At the conclusion of the experiment, there were 14 axillary shoots on the high-temperature grafted plant and but seven on the low-temperature grafted plant.

*Histology of Frenched Tobacco Leaves.* (L. H. Jones and E. C. Putala.) It was noted that severely frenched leaves, the strap and stringlike forms, were characterized by lack of palisade cells and that the space normally occupied by spongy parenchyma and intercellular spaces was composed of a mass of uniform cells closely packed, each cell with a relatively large nucleus. Less intense forms of frenching varied in their histology from the above extreme to normal tissues. Previously it has been reported that nitrogen deficiency in the tobacco plant will produce symptoms so closely resembling those of true frenching that they are indistinguishable. The histology of the leaves representing the most extreme types of nitrogen deficiency did not show any complete lack of palisade cells, although such cells were irregular in shape as compared with normal palisade cells. The nuclei of the cells in nitrogen-deficient leaves did not display the enlargement which was common to the extremely frenched leaves. In general the histology of the nitrogen-deficient leaf in its most extreme form was quite similar to the histology of frenched leaves that had not reached the strap-leaved type.

**Tomato Leaf Mold Caused by the Fungus *Cladosporium fulvum* Cke.** (E. F. Guba, Waltham.) Hybrids of English forcing tomatoes X Improved Bay State and English forcing tomatoes X Marglobe, all deriving their high degree of resistance to leaf mold from *Lycopersicum pimpinellifolium* U.S.D.A. Plant Introduction No. 112,215, are not so productive or acceptable as Improved Bay State, and no further effort with these types is anticipated.

Tomato No. 44B292, possessing the factor for immunity to tomato leaf mold from *L. peruvianum*, was crossed with Improved Bay State. Selection for immunity to the disease and commercial type in the third generation of this hybrid is now in progress. Improved Bay State is highly resistant, and No. 44B292 X Improved Bay State will be immune to all forms of the tomato leaf mold fungus.

The fall crop of New England grown greenhouse tomatoes is now 90 percent Improved Bay State, and an average increase of approximately 30 percent in yield is estimated. A reduction of 15 percent in fuel cost and 10 percent in cost of cultural practices is estimated as savings where leaf mold is not a contending factor. Only about 5 percent of the spring crop is Improved Bay State, because of the relative unimportance of tomato leaf mold in the spring growing season.

**Resistance to *Fusarium dianthi* Prill. et Del., the Cause of a Serious Carnation Wilt Disease.** (E. F. Guba, Waltham.) Our studies show that the varieties John Briry, Woburn, Eleanor, Paragon, and others cited in Mass. Agr. Expt. Sta. Bul. 436 (1946) p. 22, and Bul. 441 (1947) p. 21, have a high degree of resistance to the pathogen.

Numerous crosses of resistant varieties have been obtained. The seedlings have been screened for desirable commercial type by the investigator and co-operating agencies. Some twelve seedlings are acceptable to date and are being propagated further (approximately 12 percent of the total number released to three growers.) Some of them, on the basis of artificial infection studies, appear to be resistant to *Fusarium* wilt. Four seedlings are being released to the trade by the Sim Carnation Company, Inc.: Mrs. E. F. Guba (10 W; John Briry X Dorothy Napier); Autumn Glow (63 W; Elizabeth Rowe X Helen Hussey); Waltham Pink (48 W; John Briry X Dorothy Napier); and Regal Pink (46 W; Puritan X Helen Hussey).



Two varieties, Eleanor and John Briry, have been selfed and crossed in May and June and numerous seed pods have been obtained. It is proposed in this simplified effort to study the inheritance of resistance to *Fusarium* wilt among the progeny of this cross and these selfs, and by selfing wilt resistant seedlings for successive generations to establish pure lines for resistance to the pathogene that may be used for breeding purposes.

#### Control of Diseases of Greenhouse Crops. (E. F. Guba, Waltham)

*Control of Carnation Stem Rot and Wilt Diseases with Top Soil Applications of Chemicals.* Stem Rot (*Rhizoctonia solani*), bacterial wilt (*Phytophthora caroyophylli*), and *Fusarium* wilt (*Fusarium dianthi*) have not been satisfactorily controlled by top soil applications of chemicals. Plots not treated performed as well as treated plots. The carnation industry has abandoned the practice after having suddenly accepted it in spite of unfavorable evidence from fundamental research.

Successful control of *Rhizoctonia* stem rot is being demonstrated commercially by exposing the top portion of the root above the soil when transplanting rather than endangering the stem to infection by burying the roots completely.

Other fungicides are being studied to be sure that the subject will be investigated thoroughly before it is concluded. Disinfesting ratios of chemical to soil can be shown in laboratory studies. Fermate, Phygon, phenyl, and other mercury compounds are disinfesting either to fungi or to fungi and bacteria. Numerous chemicals indicating promise in laboratory studies are being compared in tests in the greenhouse.

*Disinfestation of Carnation Cuttings.* A suitable disinfestant for carnation cuttings is desired. Potassium permanganate is not satisfactory generally. Parzate, Zerlate, Fermate, and Bioquin Copper 8 have been recommended for dousing carnation cuttings but they are not bactericidal. Phenyl mercury acetates (Tag 331 and Puratized Apple Spray) 1-3786 or  $\frac{1}{4}$  teaspoonful to 1 gallon of water are both fungicidal and bactericidal. Immersion for 30 minutes is disinfesting. Only untrimmed cuttings should be doused. After the treatment the base of the cutting should be snapped or cut off to the next node, then the cuttings planted; otherwise, they will not root well.

Freshening cuttings in water spreads disease organisms. For disinfesting cuttings, phenyl mercury acetate is recommended where bacterial carnation wilt is a factor; otherwise, Parzate, Zerlate, Fermate, or Bioquin Copper 8 may be used.

*Investigation of Fungicides which Promise Value in Apple Disease Control.* (E. F. Guba, Waltham.) The weather during 1949 was too dry for apple scab. The monthly rainfall for April was 4.90; May, 3.73; June, 0.72; July, 1.08; and August, 1.37 inches.

Phygon XL  $\frac{1}{2}$  pound with Epsom salt  $\frac{1}{2}$  pound to 100 gallons of water russeted 32 percent of the Delicious apples. Russetting was due to Epsom salt added to prevent Phygon foliage chlorosis. These results suggest that the added Epsom salt might be omitted since 50 percent Phygon XL itself is Epsom salt. Phygon foliage chlorosis could be found on Baldwin foliage. It resulted from the second cover spray on May 25 after warm weather had occurred rather than at calyx, the previous or third application in the schedule. In the current season (1950), Phygon with the recommended amount of Epsom salt added russeted Delicious apples but not Baldwins. Sulfur with lead arsenate and 50 percent wettable DDT russeted Baldwin but not Delicious apples. Phygon foliage chlorosis was quite noticeable on Delicious foliage but only faintly present on Baldwin and McIntosh foliage.

**Systematology, Ecology and History of the Monochaetiae and Pestalotiae.** (E. F. Guba, Waltham.) This study has been in progress for many years. The confusion in the taxonomy of the genera is being clarified, and the objective is to offer a system of classification capable of utility by the customary research investigator and student in mycology and plant pathology. Presently, all of the species in forty-one orders of hosts in the plant kingdom have been studied critically where specimens could be obtained, or interpreted from description and illustration where type specimens were not obtainable. The species in four orders of hosts remain to be studied.

Several hundreds of specimens have been studied and arranged by this tentative system of classification. By this arrangement approximately 36 species of Monochaetiae and 252 species of Pestalotiae are recognized among forty-one orders of plants. One third of the original number of species have been made synonyms, and approximately another 75 have been transferred to other genera of the Fungi Imperfecti.

All of the species are being organized on the basis of spore form, number of cells and appendages, coloration, and measurable characters independent of the host, and with suitable cross indexing to show host relationships. This method should reduce considerably the number of species and simplify their classification and identification. The effort is purely scientific and taxonomic. It is intended to simplify and clarify the nomenclature of these difficult genera for the mycologist and plant pathologist.

**Causes and Control of Decay of Winter Squash in Storage.** (E. F. Guba, Waltham.) Bulletin manuscript entitled "Spoilage of Winter Squash in Storage" has been completed and submitted to the Experiment Station Administration. This publication is an illustrated monograph of all of the pathogens and forms of decay involved in the culture and storage of squash, and a presentation of all of the practices involved in the control of spoilage. It is intended to be a helpful source of scientific and practical information to all concerned.

No further work is contemplated.

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## DEPARTMENT OF CHEMISTRY

Walter S. Ritchie in Charge

**Factors Affecting the Vitamin Content of Milk and Milk Products.** (Arthur D. Holmes.) Milk is one of the most important agricultural products produced in Massachusetts. Numerous investigators have shown that when milk is drawn from the cow, it contains a significant amount of reduced ascorbic acid, and that the fresh milk produced in the United States during a year contains as much reduced ascorbic acid as is present in the entire citrus fruit crops produced in the United States annually. Unfortunately, a considerable portion of the reduced ascorbic acid present in fresh cow's milk is lost before the milk is ingested by the ultimate consumer. During the past year attention has been directed towards determining factors which are responsible for this loss. As noted in the previous Annual Report, studies in this laboratory show that the rate of loss of reduced ascorbic acid from mare's milk is only a fraction of the rate of loss from cow's milk when both are stored under identical conditions. Studies have been continued with mare's and goat's milk with the hope that such studies might point the way to eliminating the excessive loss of reduced ascorbic acid from cow's milk.

*Reduced Ascorbic Acid in Goat's Milk* (Arthur D. Holmes, Harry C. Lingle, and Eugene J. Finnegan.) Sixteen samples of goat's milk, believed to be typical of that produced in Massachusetts, were obtained from goat dairies in the vicinity of Worcester. The amount of reduced ascorbic acid present in the milk varied from 9.4 mg. per liter to 32.5 mg., with an average for the sixteen samples of 17.7 mg. per liter, an amount very similar to that found in fresh cow's milk produced by many commercial dairies.

*Decrease of Reduced Ascorbic Acid in Goat's Milk During Storage.* (Arthur D. Holmes.) Samples of goat's milk were stored for the usual 5-day experimental period in darkness at 10° C. (50° F.) to test the rate of loss of reduced ascorbic acid. The loss was 61.2 percent for the goat's milk, compared with 65.5 for cow's milk stored under identical conditions. These data suggest a similarity of the conditions in which the reduced ascorbic acid exists in the milk of these two species of ruminants.

*Day-to-day Variation of Reduced Ascorbic Acid Content of Mare's Milk.* (Arthur D. Holmes.) Twenty-three to 25 samples of milk were collected from each of four closely related Percheron mares. One mare was used during the same stage of two lactations. Identical results were not obtained for these two lactations, and the extent to which duplicate results can be obtained in repeat experiments of this type has been considered. The data assembled from each of the six lactations show that the amount of reduced ascorbic acid in mare's milk fluctuates significantly, and the value obtained from a single sample may lead to quite erroneous conclusions. To secure an accurate picture of the average amount of reduced ascorbic acid in mare's milk, it is essential to collect and assay samples of milk at relatively frequent intervals during the period under consideration.

*Loss of Reduced Ascorbic Acid from Riboflavin-enriched Mare's Milk.* (Arthur D. Holmes.) Earlier studies in this laboratory have shown that cow's milk contains approximately 10 times as much riboflavin as mare's milk, and that it loses its reduced ascorbic acid 8 to 10 times as fast as mare's milk. Hence, mare's milk was enriched with riboflavin to determine whether the added riboflavin would increase the rate of loss of reduced ascorbic acid during the usual 5-day experimental period. At the end of the period, the mare's milk still retained 85 percent of its original reduced ascorbic acid. These data seem to indicate that riboflavin is not the principal factor in causing the rapid disappearance of ascorbic acid from cow's milk, even when stored in a household refrigerator in darkness.

*Rate of Destruction of Reduced Ascorbic Acid in Riboflavin-fortified Pasteurized Milk.* (Arthur D. Holmes.) In the previous study, it was found that the addition of riboflavin to mare's milk did not significantly increase the rate of loss of reduced ascorbic acid from the milk. Accordingly, a study was made to determine the effect of adding riboflavin to pasteurized cow's milk upon the rate of destruction of reduced ascorbic acid. Riboflavin was added in amounts of 0.0, 4.0, and 8.0 mg. per liter to 19 weekly samples of pasteurized milk. At the end of 96 hours' storage at 10° C. in darkness, the samples had lost 77, 73, and 69 percent, respectively, of the original amounts of reduced ascorbic acid. Hence, the addition of synthetic riboflavin to pasteurized milk did not significantly increase the rate of loss of reduced ascorbic acid from the milk.

*Comparison of the Stability of Reduced Ascorbic Acid in Raw and Pasteurized Milk.* (Arthur D. Holmes.) It has been repeatedly shown that reduced ascorbic acid is lost from cow's milk during the pasteurization process. This raised the question whether pasteurization merely destroyed a portion of the reduced as-



corbic acid or whether, in addition, the heat treatment altered the reduced ascorbic acid or the combination in which it occurs in raw milk so that the stability of reduced ascorbic acid in pasteurized milk is different from that in the raw milk from which it was taken. Average values obtained from two series of 20 samples show that the pasteurization process not only destroys a portion of the reduced ascorbic acid in milk, but renders the remaining ascorbic acid somewhat less stable than that which occurs in unpasteurized milk.

*Changes in Vitamin Content Coincident with Different Stages and Rates of Maturity of Vegetables Used for Home Consumption.* (Arthur D. Holmes.)

*Comparison of Light vs. Darkness for Storing Butternut Squashes.* (Arthur D. Holmes, Albert F. Spelman, and Robert T. Wetherbee) One hundred thirty well-colored, fully matured Butternut squashes, grown under experimental conditions at the Waltham Field Station, were divided into two comparable lots which averaged 1190.9 gm. and 1192.5 gm. per squash. The two lots were separated by a  $\frac{1}{4}$ -inch cardboard partition and were stored for 8 weeks under the same conditions, except that one lot was stored in darkness and the other in controlled, continuous, artificial illumination supplied by four 20-inch white fluorescent bulbs placed beneath a 46 x 49-inch metal reflector which was suspended 24 inches above the squashes. The water content of the squashes remained fairly constant during the experimental period; the reduced ascorbic acid increased during the first 4 weeks and decreased during the second 4 weeks; the carotene increased during both of the 4-week periods; the total sugars increased during the first 4-week period, but not during the second 4 weeks' storage. However, in all instances the amount of reduced ascorbic acid, carotene, and total sugars was larger in the squashes stored under artificial illumination than in comparable squashes stored in darkness. Unfortunately, the storage life of the squashes was short as compared with Hubbard squashes stored under similar conditions.

*Darkness Prolongs Storage Life of Butternut Squashes.* (Arthur D. Holmes.) Squashes used in this study were produced by Eastern States Farmers' Exchange under carefully controlled conditions maintained in genetic studies designed to develop a commercially desirable strain of Butternut squash. One hundred twenty fully matured, well-colored squashes were divided into two comparable lots which averaged 999.1 and 997.5 gm. and stored for 245 days, one under continuous artificial illumination and the other in darkness. Otherwise, both lots were exposed to the same experimental conditions. Weight and spoilage losses were slightly larger for the squashes stored in light than for those stored in darkness. At the end of the storage period, more of the squashes that had been stored in darkness than of those stored in light were marketable. The storage life of the squashes used in this study was four to five times as long as that of the squashes used in the previous study. The seed which produced the squashes used in this study was treated to eliminate all seed-borne diseases.

*The Production of Holocellulose from Nonwoody Plant Tissue.* (Emmett Bennett.) In previous work at this station, it has been shown that holocellulose containing all the hemicelluloses may be produced from nonwoody plant tissue. The holocellulose fraction therefore appears to be an ideal substance for use in determining hemicelluloses quantitatively. Isolation of the holocellulose fraction, however, is attended with difficulties. Therefore, in the interests of accuracy and economy of time, it would be desirable to extract and determine hemicelluloses directly without previously isolating the holocellulose. One of the most promising procedures attempted involves the use of perchloric acid as a solvent

for hemicelluloses. The solvent action of dilute perchloric acid on isolated hemicellulose is considerable. Extraction of pentosans in the associated form has been accomplished, but as yet it is not known whether the removal of these products is accompanied by a general fragmentation of the cell wall and hence the removal of other material as well, or whether the solvent action is somewhat specific for the polymers of shorter chain length.

The hemicelluloses of cornstalks were investigated rather thoroughly. The significance of fractionations and some variations in chemical structure are described in *Archives of Biochemistry*, 27:99 (1950). In general the fraction most difficult to extract was characterized by the lowest percentage content of methoxyl and uronic acid anhydrides, but the highest percentage content of xylan, the greatest number of sugar residues per nonreducing end group and, consequently, the highest apparent molecular weight. The anhydro sugar residues seem to be linked by either the 1, 2 and/or 1,4 glycosidic linkage. Glucose, galactose, xylose, and arabinose were found in all hemicellulose fractions but in different molar ratios. Paper chromatographic techniques were used in separating the sugars in the hydrolyzate mixture and in their quantitative determination.

**Investigation of Agricultural Waste Products. II. The Chemical Composition of Certain Wild Plants, with Special Reference to the Content of Alpha Cellulose, Polyuronides, Gums, and Soluble Sugars.** (Emmett Bennett.) Plants are storehouses of many important chemicals. A knowledge of the distribution of such compounds is of prime importance in a consideration of chemical transformations and of economic interests. In this investigation plants of no particular economic importance at present are being studied to determine their possibilities as sources of definite carbohydrate fractions listed in the title. Collections and data are too incomplete to warrant further statements at this time.

**Yield and Composition of Alfalfa Varieties as Influenced by Rates of Exchangeable Potassium.** (Mack Drake and Jonas Vengris.) Three varieties of alfalfa, Kansas Common, Buffalo, and Atlantic, were grown in greenhouse pots on a Merrimac fine sandy loam, low in exchangeable K (potassium) and in total base exchange capacity. The soil was limed to pH 6.5 and was supplied with adequate amounts of nitrogen and phosphorus. Potassium was supplied at three levels of exchangeable K (0.125, 0.25, and 0.5 milliequivalents of exchangeable K/100 gm. soil) by adding K-bentonite to the soil. Both yield and K content of the plants were increased by added increments of K, the composition ranging from 0.3 percent for the low level of K to 1.95 percent K at the high level of exchangeable K in the soil. In the first cutting, at each level of exchangeable soil K, the dried forage of Atlantic alfalfa was 10 to 30 percent lower in K and was correspondingly higher in calcium and magnesium than was the forage from Kansas Common or Buffalo. However, only small differences between varieties in composition were present in the second and third cuttings. At the lowest level of K, Kansas Common in the first cutting produced 22 percent more dry matter than either Atlantic or Buffalo, and this trend in yield differences at the low level of exchangeable K continued in the second and third cuttings. At the higher rates of K, there was no difference in yields between varieties. Relative dry weights of roots after the fourth cutting (300 days) were as follows: at lowest level of exchangeable K—100, 49, and 45, respectively, for Kansas Common, Buffalo, and Atlantic; at medium level of exchangeable K—100, 72, and 82; and at the highest level of exchangeable K—100, 61, and 60, respectively, for Kansas Common, Buffalo, and Atlantic.

The tap roots of the variety Kansas Common were double the size of those of Buffalo and Atlantic. Although Atlantic plants showed considerable branching

and lateral root development, Kansas secondary roots were developed almost as much as those of Atlantic.

**Effects of Ammonium Nitrate on Yield and Composition of Hay.** (Mack Drake and Wm. G. Colby.) A study of the effect of spring top-dressing of grass-clover and timothy with nitrogen supplied as ammonium nitrate was made on Suffield silt loam (poorly drained) in the spring of 1949. Rainfall during this period was below normal.

The data indicate the great nitrogen requirement of hay lands in Massachusetts. Even when the meadow contained considerable clover with the blue grass and timothy, applied nitrogen increased both yield and protein content of the hay, and the rate of increase of hay yield and protein content per pound of applied nitrogen remained high through the highest rate of nitrogen application (90 pounds acre). The increased nitrogen content of the hay was equal to 65-75 percent of the highest rate of nitrogen applied.

Since these values do not include the nitrogen contained in the increased root growth, one must conclude that in this test the efficiency of ammonium nitrate applied as a spring top-dressing was very high. It is believed that, although the yield might have been higher, the protein content of the hay would have been much lower if the hay had been cut at a date later than June 12.

**Yield and Composition of Ladino Clover as Influenced by the Rate and Ratio of Potassium, Calcium, and Magnesium in the Soil.** (Mack Drake and Philip B. Turner. In cooperation with Agronomy.) A greenhouse pot experiment in which Ca-Mg-K (calcium, magnesium, and potassium) were supplied to a soil in exchangeable and nonexchangeable forms was conducted to determine the Ca-Mg-K rates and ratios which would give the best yields and composition of Ladino clover. The soil used was a Merrimac fine sandy loam, low in exchangeable bases and in base exchange capacity. The data obtained suggest the following conclusions: Yields of Ladino clover were increased by added increments of Ca-Mg-K bentonites. Although high yields of forage were produced with high levels of exchangeable Ca-Mg-K, the composition was undesirable as the percentage of K was too high and the percentage of Ca and Mg was too low. The combination of high rates of exchangeable Ca-Mg-K with dolomitic limestone increased the yields and improved the mineral composition of the forage.

In a comparison of 12,000 pounds of high-calcium limestone ( $\text{CaCO}_3$ ) and 12,000 pounds of dolomitic limestone ( $\text{Ca MgCO}_3$ ), the yields of Ladino forage were high and were comparable for both treatments. Although no magnesium deficiency symptoms could be detected, plants with high-calcium limestone contained as low as 0.07 percent magnesium, while plants with dolomitic limestone contained 0.45 - 0.65 percent magnesium. The forage from high-calcium lime contained 10 percent more potash than forage from the dolomitic limestone, so that in addition to producing forage with a more desirable mineral content, dolomite should effect more efficient use of potassium. Thus the use of dolomitic limestone is to be recommended in general over the use of high-calcium limestone for Ladino clover. High rates of lime require high rates of potash for best yields. Lime at the rate of 6000 pounds dolomite per acre with 60 pounds  $\text{K}_2\text{O}$  initially and 60 pounds  $\text{K}_2\text{O}$  after each cutting produced forage of desirable (high) calcium and magnesium content. Somewhat higher rates of potash would be required for a grass-Ladino mixture. A comparison was made of 6000 with 12,000 pounds of dolomite per acre when 240 pounds  $\text{K}_2\text{O}$  were applied at planting and again after the second cutting. Forage grown with 12,000 pounds of dolomite contained a higher percentage of calcium and magnesium and 15 percent less potash



than that with 6000 pounds of dolomite. Thus if it is impractical to make small, frequent top-dress applications of potash because of wet land, labor requirements, etc., high yields of forage of more desirable (higher) calcium and magnesium content will be produced, and more efficient use of potash will be made by the use of higher rates of dolomitic limestone.

**The Nutrition of Apple Trees.** (In cooperation with Pomology and Agronomy.) (Mack Drake, W. D. Weeks, F. W. Southwick, and Dale H. Sieling.) Leaf weight and chemical composition were determined on leaves sampled in July 1949 from a mulch fertility experiment of 16-year-old McIntosh apple trees. In general, the nitrogen content of leaves from heavily mulched plots was decreased and from plots receiving nitrogen as ammonium nitrate was increased as compared to analysis of 1948 leaves. Hay used for mulch was analyzed and applied in amounts to supply nitrogen equal to the amounts supplied by increments of ammonium nitrate.

**Dental Caries.** (Julia O. Holmes.) The objectives of this study have been to obtain a better understanding of the factors which determine susceptibility to tooth decay and to find methods for reducing or preventing tooth decay in man. Approximately 800 albino rats of a highly caries-susceptible strain have been studied during the year. In the majority of the studies, the rats have been housed in individual metal cages provided with a wide-mesh screen flooring to prevent the eating of excreta or bedding materials, and fed *ad libitum*, unless otherwise specified, for a 60-day period. When two or more ratios were being fed, littermates, preferably of the same sex, were placed on each ration. The rations have been composed of 10 to 50 percent "Labco" casein, 38 to 78 percent dextrose, 4 percent corn oil, 4 percent mineral mixture, 4 percent liver fraction #L, and water soluble and fat soluble vitamins in sufficient amounts to assure good growth and health. The standard cariogenic ration contained 15 percent casein.

**Casein-rich Rations.**—The testing of the 50 percent casein ration for its anti-cariogenic property has been continued. Twenty pairs of littermate rats have been compared this year, one of each pair receiving the 15 percent casein ration and the other the 50 percent casein ration. The majority of the rats were reared to weaning age by mothers receiving a synthetic ration containing 63 percent sugar during pregnancy and lactation. Sound, caries-free teeth were found in all but one rat receiving the 50 percent casein ration for 60 days; whereas all rats receiving the low-casein standard cariogenic ration had marked tooth decay.

**Natural Food Ration.**—Additional data have been secured concerning the effectiveness of the standard breeding ration, containing whole milk powder, ground whole wheat, salt, and meat scraps, in preventing tooth decay in the young growing rat. All rats fed this ration, irrespective of whether their mothers had received the breeding ration or a sugar-rich ration during pregnancy and lactation, were completely free of tooth decay. The protein content of the breeding ration approximated 15 percent.

**Fluorine.**—Fluorine contamination of the casein, as a possible cause of the caries-inhibiting action of casein-rich rations, has been investigated. Fluorine concentrations of 10, 15, 30, 45, 60, and 90 p.p.m. of the standard cariogenic ration have been fed. Rats receiving 60 p.p.m. have not been completely protected against tooth decay; hence, the quantity of fluorine necessary to give the degree of protection observed in the 50 percent casein-fed rats appears to be in

excess of 60 p.p.m. The yellow pigment of the incisor teeth was pale and unevenly distributed in the rats fed fluorine at the 90 p.p.m. level; in those receiving all lower levels (10 to 60 p.p.m.), definite, uniform striations were present in the pigment. In none of the rats receiving the 50-percent casein rations have striations in the pigment layer been detected on careful examination. If the casein was contaminated with fluorine, the amount present must have been less than 10 p.p.m., an amount far too insignificant to protect against decay under the conditions of the experiment. The caries-inhibiting effect of the 50-percent casein rations, therefore, must be due to some factor other than fluorine.

*Potassium Oxalate and  $(\text{NH}_4)_2\text{HPO}_4$ .*—Potassium oxalate, at a level of 0.3 percent or ammonium phosphate at a level of 0.5 percent of the standard cariogenic ration did not inhibit or retard tooth decay in this species of rodent. Higher levels of both are now being investigated.

*Methionine.*—The caries-aggravating effect of DL-methionine observed earlier in 38 of 44 littermate pairs of rats has not been consistently found in two subsequent groups of rats. In view of the finding that rats receiving this compound eat poorly, especially in the beginning of the feeding period, an equalized feeding test was conducted in which both rats being compared were given the same quantity of food. In 10 of the 13 groups, the methionine-fed rats had definitely more tooth decay than did their controls; the increases in the number of sites of decay and in the total extent of decay, respectively, averaged 40 and 100 percent. Interproximal caries, particularly between the first and second upper and lower molars, occurred more frequently in the methionine-fed rats.

*Quantity of Food.*—The influence of the quantity of food eaten on the degree of tooth decay observed in the experimental animals was studied in an attempt to determine the cause of the variability in tooth decay found in groups of rats fed identical rations. Twelve groups of rats, each containing three littermates of the same sex and weight were fed the standard cariogenic ration under controlled feeding conditions, in which one rat of each group ate *ad libitum*, and the other two rats received, respectively, 80 and 60 percent of the quantity of food eaten by their "*ad libitum*" littermate. In eight of the nine groups evaluated to date, the rats consuming food *ad libitum* had markedly more severe caries than did their more abstemious littermates; in seven of the groups the "80 percent" rat had higher caries scores than did its "60 percent" littermate. These data point to the need for equalized feeding techniques in studies in which two or more rations are being compared and necessitate a re-evaluation of data obtained with *ad libitum* feeding.

The study of the relationship between the maternal diet and susceptibility to tooth decay in the offspring has been continued. Instead of feeding the standard cariogenic ration which resulted, in the earlier study, in poor reproductive performance, all of the essential nutrients in this ration were increased by 50 percent, the result being that reproduction and lactation were fully equal to that obtained on the standard breeders' ration of natural foods. Fifteen healthy young mature female rats, reared on the standard breeders' ration, were continued on the same ration during their first reproduction, fed the synthetic sugar-rich ration during their second, and in some cases received the standard breeders' diet during the third reproduction. The young were placed on the standard cariogenic ration at weaning and fed for sixty days. The young reared by mothers receiving the natural food ration developed marked caries, a condition consistently observed in this strain of rats. Only a few litters reared by mothers on the improved, synthetic sugar-rich ration have been examined for caries; the data collected to

date scarcely justify the current theory that a sugar-rich maternal ration, fed during the periods of tooth development, calcification, and eruption in the offspring, markedly increases the susceptibility of the offspring to dental caries.

*Sex Difference.*—The records of 100 pairs of brother and sister rats have been studied to determine whether or not a sex factor in susceptibility could be demonstrated. Consistent differences were not observed.

*Dicarboxylic Acids.*—Aspartic acid, at a level of 2 percent, eroded the dentine on the occlusal surfaces of the teeth in apparently the same manner and to the same extent as does glutamic acid. The abnormal erosion was completely prevented by the inclusion of 30 p.p.m. of fluorine in a ration containing 2 percent glutamic acid, but not by 10 p.p.m. of fluorine, 0.3 percent potassium oxalate, or 2 percent urea.

*The Influence of Factors Concerned with the Type of Bedding of the Rats.*—Littermate rats were placed in cages (a) directly on sawdust and with access to excreta as well as to sawdust, (b) on a wide-mesh wire screen to reduce the eating of excreta, (c) on the screen and given a cup of sawdust, and (d) on paper with access to both paper and excreta. Consistent differences in tooth decay among the four rats in each group did not occur. The data indicate that in this species tooth decay was not influenced by the chewing or ingestion of excreta, sawdust, or paper. Equalized feeding techniques were not used; because of scattering of food, it was impossible to secure accurate food consumption data for the rats bedded on sawdust.

*Suitability of Strain of Rats for Dental Caries Studies.*—The highly caries-susceptible rats appear to be as suitable for dental caries studies as are other species of rodents. Carious lesions develop rapidly in the molars, and by the sixtieth day of the experiment are well established but only infrequently have progressed to the stage of cavitation. Fracturing of the cusps, unaccompanied by soft discolored dentine immediately beneath the fracture, is seldom if ever encountered. The extensive carious involvement of dentine without fracturing or cavitation affords proof that the decay is not induced by an initial fracturing. Fully one-third of the total sites of decay occur in the upper molars. Lesions are found in the deep fissures between the cusps of both upper and lower molars in 100 percent of the animals, and in approximately 30 percent of the animals early decay is found on the interproximal surfaces. Lesions are rarely found on the grinding surface or on the tongue side of the molars but have occurred in many rats on the cheek side of the molars at the gingival margin. The latter lesions as well as the interproximal lesions appear as opaque areas surrounded wholly or in part by yellow enamel. The presence of soft yellow dentine at the dentine-enamel junction beneath the opaque areas is proof that the opaque areas are early carious lesions. Cavities at the gingival margin have seldom been found. In those rats fed "soft" diets, decay has been observed at sites which do not undergo decay in rats fed coarsely ground cornmeal.

(These studies were aided by a contract between the Office of Naval Research, Department of the Navy, and the University of Massachusetts (NR 181-485) and by a grant from the National Dairy Council, Chicago. Because of lack of supporting funds for the coming year, the project is being discontinued.)

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THE CRANBERRY STATION  
East Wareham, Massachusetts  
H. J. Franklin in Charge

**General.** Severe drought and excessive sunshine in July and August prevented the general size of the berries of the 1949 cranberry crop in Massachusetts from



becoming greater than normal, so that the harvested total, 530,000 barrels, was probably considerably smaller than it would have been otherwise. A station forecast of poor general keeping quality for this crop, made in mid-June, was fully verified in the fall, especially with the early varieties. Because of a heavy carry-over in freezers from the crop of the year before, cranberry prices were lower than for many years.

**Injurious and Beneficial Insects Affecting the Cranberry.** (H. J. Franklin.) The three final parts of the work on cranberry insects were finished and presented for publication. The insect and disease control chart and the cranberry weed control chart were revised again.

The botanical insecticide *Ryania* was tested fairly extensively, both as a dust and in a spray, as a control for the cranberry fruit worm. It gave a kill of this pest comparable to that obtained with rotenone, but the spray stunted the berries quite noticeably. It is believed that the stunting may have been caused by a wetting agent added to the spray. *Ryania* failed to kill blunt-nosed cranberry leafhoppers.

Ten percent DDT dust, used at the rate of 50 pounds to an acre, was found to be a more satisfactory control for the green cranberry spanworm than the arsenate of lead spray used heretofore, being less expensive and more lasting in its effects.

Chlordane, applied as a dust and also used in sprays as a 40 percent wettable powder and as an emulsion concentrate, proved altogether ineffective as a treatment for root grubs, even when used in unreasonable excess.

*Prevalence of Cranberry Insects in the Season of 1949:*

1. The black-headed fireworm did not give much trouble, being rather definitely less abundant than normal.
2. The gypsy moth was about normal in Plymouth County but was well controlled by the growers there, and it gave very little trouble in Barnstable County because of the extensive airplane spraying done in that county by county, state, and federal agencies cooperating.
3. The false army worm was quite troublesome, having been as abundant only in occasional years in the past.
4. The green spanworm was very widely and severely troublesome, more so than for many years. It was very effectively controlled in many cases by dusting with 10 percent DDT.
5. The cranberry girdler gave very much less trouble than usual and was in fact almost conspicuous by its absence.
6. The cranberry scale (*Aspidaspis oxycoccus*) was troublesome on more bogs than usual.
7. The armyworm (*Cirphis*) appeared on one bog from which the long summer grub flow had been let off on July 15, this being somewhat later than this insect normally appears on bogs.
8. The fire beetle and the red-striped fireworm were not encountered during the season.
9. Bees in general were quite plentiful during the cranberry blossoming period, bumblebees being noticeably much more abundant than usual.
10. The fruit worm was about normally abundant and in general was very well controlled.
11. A species of cutworm (*Hyppa xylinoides*) not heretofore found attacking cranberries appeared in abundance on one bog after late removal of the winter

flood. This worm was working together with other cutworms commonly found after late holding of the winter water.

12. Tipworms were rather noticeably abundant except where they had been controlled by resanding or by dusting with DDT.

13. The cranberry weevil was widely troublesome but seemed to be controlled fairly well in most places by treatment with DDT.

14. The white-marked tussock moth, *Heemerocampa leucostigma* (S. & A.), was found the first week in July to have broken out severely on a few hundred acres of land on the western end of Nantucket Island, the worms being present in nearly all stages of growth. They had cleaned up entirely a very good crop promise on ten acres of cranberry bog by nipping off the blossoms, but had not eaten the foliage severely. The insect had been particularly severe in its attacks on scrub oaks, defoliating them entirely wherever they were abundant. It had also attacked severely swamp blueberry, wild rose, Clethra (sweet pepperbush), clammy Azalea, beach plum, iris, bayberry, and black huckleberry.

**Frost Forecasts.** (H. J. Franklin.) Afternoon and evening forecasting of frosts for the cranberry bogs was sponsored by the Cape Cod Cranberry Growers' Association and continued as in previous years, there being 213 subscribers to the special telephone service in the season of 1949 and 176 in the season of 1950. Frost warnings, prepared in cooperation with the Office of the United States Weather Bureau at Logan Airport, were sent out by radio through Station WBZ in 1949 and through Stations WBZ, WNBH, WBKA, and WOCB in 1950.

The wind that comes with a sharp rise in the barometer beginning in the middle afternoon or later nearly always continues to blow more or less throughout the following night.

Temperatures on cold, clear nights in the spring on most of the Massachusetts cranberry bogs fall at an average rate of about 1 degree an hour until sunrise after it has been calm for two hours. This rule does not hold for nights in the fall.<sup>1</sup>

**Control of Cranberry Bog Weeds.** (C. E. Cross.) Two hundred forty strictly experimental tests and about forty commercial scale tests were made with kerosene; Stoddard Solvent (2 types); sodium, ammonium, and isopropanolamine salts of 2,4-D; ferrous sulfate solutions; copper sulfate solutions; borax solutions; and sodium trichloroacetate, with the following results: Post-harvest spraying of kerosene on grasslike weeds adjacent to irrigation ditches was effective and almost wholly selective (leaves of cranberry vines slightly yellowed but no lasting injury). Stoddard Solvent must be sprayed at 600 gallons per acre to control small brambles; 400 gallons per acre for asters, loosestrife, and various rushes and sedges; and 200 gallons per acre for sand spurrey and water purslane. All such spraying must be done when humidity is high, to achieve permanent control, and before cranberry buds have opened in the spring or after harvesting to achieve nearly complete selectivity. The three salts of 2,4-D gave satisfactory control of 3-square grass when 20 percent solutions were lightly wiped on the weed stems. Ferrous sulfate solution, 1 pound per gallon of water, gives excellent control of seedling pitchforks in the cotyledonary stage of development. In the autumn, both ferrous and copper sulfate sprays were found to burn selectively the leaves and stems of white violets, asters, cinquefoil, and various St. John's worts. Further studies must be made to determine the lasting values of such sprays. Borax solutions applied in late summer killed cranberry vines at dosages of 150 pounds per acre or more, and no weeds under test were killed by this

<sup>1</sup> See Mass. Agr. Expt. Sta. Bul. 433, 1946, p. 51.

amount. Sodium trichloroacetate in solution at 80 pounds per acre injured cranberry vines without affecting weeds.

An inexpensive herbarium case has been procured, and plant specimens representing 332 genera and 584 species have been identified and classified in it.

Several tests were made, during the dry summer of 1949, with dilute water-soluble waxes sprayed on cranberry vines at the rate of 200 gallons per acre. Preliminary observations show no detrimental effects to cranberry vine physiology, a rather marked lessening of the damaging effects of dry weather, and an apparent though slight increase in the size of berries where the sprays were applied.

**Soil Water Studies.** (F. B. Chandler.) Studies of soil water indicate very little or no movement of water horizontally through the peat. When the tension read 2.0 inches or more of mercury (cups set 6 inches in soil), water would not go into the bog from the ditches, and the soil continued to dry out until it rained or the bog was sprinkled. This has been observed in two locations at the State Bog and at Trufant's bog, in studies made in 1948 and 1949. Water in the wells near the tensiometers indicated that the water table was 12 to 17 inches below the surface when the tensiometers read 2.0 inches. The new manometer liquid, acetylene tetrabromide colored with an oil-soluble, sunfast pigment, was very satisfactory in most bogs. In a few bogs that were operated very dry, acetylene tetrabromide was not satisfactory.

**Fertilizer Requirements of Cranberry Plants.** (F. B. Chandler and William G. Colby.) Data have been assembled in tables for a cranberry fertilizer bulletin, and the manuscript has been started. No difference in yield was found between available sources of nitrogen or between different seasons of application of the fertilizer on Early Black vines. Rot was not increased unless fertilizer was applied in amounts great enough to give excessive vine growth. The present fertilizer studies are with materials to be applied in the flood water, in sprays, in dusts, and with sprinklers. As all of these nearly eliminate the cost of applying the fertilizer and some of them use cheaper materials, it is assumed that growers will be very interested in the results.

**Cranberry Breeding.** (F. B. Chandler, collaborator, and H. F. Bergman, U.S.D.A.) Cuttings from three new cranberry varieties, named Stevens, Wilcox, and Beckwith, have been set in a number of bogs in Massachusetts for propagation and will be distributed later through the Cape Cod Cranberry Growers' Association. Other selections are still being studied, and selections will be made this fall from the seedlings growing in Massachusetts.

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## DEPARTMENT OF DAIRY INDUSTRY

D. J. Hankinson in Charge

**Sanitizing Agents for Dairy Use.** (W. S. Mueller.) The object of this investigation has been to find new and better chemical sanitizing agents for dairy use, and also to improve the effectiveness of some of the commonly used methods of sanitizing dairy equipment.

1. *New Chemical Sanitizing Agents.* (W. S. Mueller.) Preliminary tests indicate that alkyl morpholinium alkyl sulfate may be used as a sanitizing agent. This compound was found to be stable chemically and to have good germicidal properties. In addition to having germicidal properties, this compound has greater detergency power and also greater deodorant properties than the quarter-



nary ammonium compounds now commonly used as sanitizing agents on dairy farms and in dairy plants.

2. *Manner of Germicidal Action of Quaternaries.* (W. S. Mueller and R. M. Burkhardt.) In studying the bactericidal properties of the quaternary ammonium compounds it was found that here, as well as in the use of many other germicidal agents, a few organisms survive the effects of the germicide under a given set of conditions. The object of this study has been to find a satisfactory explanation for the survival of these organisms. The possibility that the bacterial population is comprised of components of different degrees of resistance was investigated. Approximately two hundred tests were made, subjecting *E. coli* organisms to a quaternary germicide, to determine whether the first subculture differed appreciably in resistance from the parent cultures. It was found that the subcultures were less resistant to the germicide than the parent cultures. The possibility that the quaternary causes the organisms to clump or agglomerate, thus protecting the organisms in the center of the clumps from the germicide, was also investigated. So far the results indicate that clumping is not a major cause for a few organisms surviving the killing action of a germicide when the majority of organisms are killed.

3. *A Micro Method for Evaluating Germicides Determining 100 Percent Kill.* (W. S. Mueller.) Methods for evaluating quaternary germicides usually involve a comparison of the time required to kill a definite percentage of standard test organisms. Some methods make provision for an end point of 100 percent kill while others have end points which are slightly less than 100 percent. An end point of 100 percent kill is very desirable if it can be determined accurately. This investigation was made for the purpose of developing a better method for determining 100 percent kill. A micro method was developed which is based on the use of a magnetic stirrer and also on a micro procedure for making the agar plate colony count. Advantages of the new micro test method are:

- (1) It is conveniently and rapidly performed.
- (2) A minimum amount of incubation space is required for a large number of tests.
- (3) The incubation for determining surviving organisms is made in the test dish, thus simplifying the procedure.
- (4) Small amounts of materials are required. Only 1 ml. of nutrient agar is needed for each micro petri dish.

This method has been published in *Modern Sanitation*, Vol. 2, No. 6, pp. 45-46, June 1950.

4. *Detergent-Sanitizers.* (W. S. Mueller.) A new departure from the common method of washing and then sanitizing dairy equipment is the use of a detergent-sanitizer which combines cleaning and initial sanitizing in one operation. This new procedure is being investigated for its effectiveness, and it is concluded that while detergent-sanitizer combinations have not been perfected, they do appear promising enough to receive further attention.

A paper on detergent-sanitizers was published in *Milk and Food Technology*, Vol. 12, No. 4, pp. 240-243, July-August 1949.

5. *Sanitization of Dairy Utensils by Heat.* (W. S. Mueller and W. T. Geenty.) Warm water is essential for proper washing of dairy equipment. Also hot water and steam have certain advantages over chemical agents for sanitizing dairy equipment. It has always been a major problem to supply these economically on dairy farms in sufficient quantities. Recently there has been introduced in

New England a small equipment unit consisting of a heater (available for burning natural or manufactured gas, stove oil, kerosene, or Diesel oil), a two-compartment wash sink, and a sterilizing cabinet. The heater will produce either hot water or low-pressure wet steam. The chief purpose of this investigation is to determine how far this equipment will go in solving the dairy farmers' hot water and heat sanitization problems. Efficiency test studies have been made using bottled gas as the fuel supply, and the heater was found to produce a continuous supply of hot water or steam at approximately 70 percent efficiency in fuel consumption. By engineering standards, this is considered to be very good. It was also found that the heater would produce hot water or steam within less than two minutes after lighting. While studies have not been completed, the results so far obtained indicate that this type of equipment would serve a very useful purpose on dairy farms.

**Effect of Certain Antioxidants on the Flavor and Keeping Properties of Milk and Some of Its Products.** (W. S. Mueller and E. J. Finnegan.) The object of this study has been to obtain further information on the antioxidative properties of various materials when added to dairy products. Investigations were also made to find a tool which is better than the Swift's Fat Stability Apparatus for measuring the effectiveness of an antioxidant in dairy products. Such a tool which has been investigated is the "Stinkometer." This apparatus has been used by other investigators for measuring the volatile reducing substances in various foodstuffs, as an index of the degree of spoilage. This method is based on the use of aeration for determining the volatile constituents.

In this study the outlet of the aeration of the Swift Fat Stability Apparatus was connected to the inlet of the reaction vessel of the "Stinkometer" apparatus. By this means it was possible to obtain data on the two different test apparatus by aerating one sample of the dairy product under investigation. The "Stinkometer" value proved to be more sensitive to oxidative changes in aerated samples of butteroil than the peroxide value. This was true especially during the initial stages of the induction period which is the critical period for noting changes.

Further studies with cacao shell corroborated earlier findings that this material contains a potent antioxidative substance.

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## DEPARTMENT OF ECONOMICS

Philip L. Gamble in Charge

**Transfer of Ownership and Its Effect on Agricultural Land Utilization.** (David Rozman.) Work on this project has continued with the gathering of basic data and the analysis of the material for completion of the study. Seven towns in scattered locations, with different types of farming, were covered by the investigation. Changes of land ownership were examined for the 9-year period 1940-1948, and all land transactions of 3 acres and more were taken into consideration. The principal points and conclusions revealed by the study are as follows:

1. The total number of land transfers, including resale of some properties, amounted to about two-thirds of the individual land holdings over the 9-year period.

2. The number of land transfers has been increasing since 1940 and reached its climax in the two postwar years, 1946 and 1947.

3. Advanced age of former farm owners and demand for land on the part of returning veterans were contributing factors in the high rate of land transfer in the postwar period.

4. The increased sales of part-time farming and non-agricultural land holdings in the early post war period were due mainly to the demand for housing accommodations in rural areas by people from urban communities.

5. As a result of all transactions, the amount of land in farming has declined by about the same area as it increased in part-time farming; the land area in other uses has not shown any appreciable change over the 9-year period. The most important result, therefore, has been the transfer of land from farming to part-time farming.

6. Although a certain number of transactions involved purchases for the purpose of investment in rural land or for resale at higher prices, neither of these factors attained great importance in the total transfer of property.

7. Most of the sales of land held by banks and corporations occurred in the early period of the war, as soon as the land market became favorable.

8. Non voluntary sales were very few throughout the period. Only 10 farms with 1,155 acres were involved in forced sales, all in the early years. No farm was sold in these transactions after 1944.

9. Purchase of land to be added to existing farms has been an important factor in the transfer of ownership. There were 83 transactions for that purpose, involving 2,397 acres of land.

10. The majority of farms purchased in the early war period were on a cash basis. In the post war period the purchases of farms on a mortgage basis were more frequent.

11. Although the total land area included in farms in Massachusetts has declined during the last decade, the productive capacity has actually increased. This has been due both to better treatment of farm lands in general and to measures of conservation and rehabilitation of land in farms.

12. The higher rate of transfer in farm land ownership has contributed towards better treatment of land resources. This conclusion is based on data indicating greater participation in land improvement and soil conservation programs on the part of new owners.

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## DEPARTMENT OF ENTOMOLOGY

Charles P. Alexander in Charge

Investigation of Materials which Promise Value in Insect Control. (A. I. Bourne and W. D. Whitcomb.) The cooperative project with the Dow Chemical Company was continued. Dormant applications were made on cultivated blueberries with Dow Co. Dn-289 and a tank-nix Superior oil emulsion, for the control of the blueberry Lecanium in the small area of the college planting in which the pest still persisted. As the season developed and the plants came into foliage, no injury from either type of spray was observed. The unsprayed barrier rows also showed no evidence of winterkilling. This was in contrast to 1948 when severe winterkilling of tips took place and raised some uncertainty in the minds of observers whether Dn-289 had or had not caused the damage or aggravated the injury. In a spring following almost no winter injury, neither Dn-289 nor oil emulsion caused any damage, which would seem to settle the question of safety of Dn-289 on the plants. Subsequent counts of scale showed 8 percent mortality on unsprayed check plants, 87 to 88 percent mortality on plants sprayed with Dn-289, and 93 to 94 percent mortality on plants sprayed with oil emulsion; indicating a very high winter survival of the scale, very satisfactory control by both materials applied, and very little significant difference between the two types of spray used.



For control of overwintering aphid and red mite eggs, Baldwin and McIntosh trees in Block A were sprayed with Dn-289 at 2 quarts per 100 gallons. Buds were in dormant stage; weather, fair and clear; temperature 60°F. Trees showed a comparatively light carry-over of aphid eggs and even fewer red mite eggs. The first newly hatched aphids were found in the college orchard and commercial orchards in the vicinity, April 4 and 5. Subsequent counts showed 50 aphids per 50 buds on unsprayed Baldwins and 235 aphids per 50 buds on unsprayed McIntosh. No living aphids were found on sprayed trees. The number of red mites which hatched in this block was too low to give conclusive results.

*Pear Psylla Control*.—Parathion (25 percent wettable powder) at  $\frac{1}{2}$  pound per 100 gallons and Dn-289 were applied as the blossom buds were breaking and both gave excellent control of pear psylla. Adults, eggs, and nymphs were killed. Counts just previous to application showed numerous psylla flies, and eggs varying in number from 285 to 2655 per 25 fruit spurs. Subsequent examinations showed that practically all active stages were killed and the eggs failed to hatch. It is a matter of record that no further treatments for psylla control were needed during the remainder of the season in that orchard.

Parathion applied at approximately monthly intervals during the summer to different varieties of pears caused no injury to any variety, even Bosc. An application as late as August 12 caused no visible injury to foliage or to ripening fruit.

*Oystershell Scale Control*.—Dn-289 at 3 quarts per 100 gallons was applied in the dormant season at a private estate in Amherst. The infestation was moderate to heavy, but no deep encrustation of scale was present. Some pruning of dead branches had been done previous to spraying. Overwintering eggs were hatching in late May, just before the 30th. Rather cold weather during the last week of May slowed down somewhat the appearance of young. The property owner reported that he was unable to find any young scales. Examinations made by us in late June and later in the summer indicated that very little hatch had occurred. The new terminal growth was practically free of scales.

Examination of lilac plantings on the lawn of one of the staff in West Pelham, sprayed with Dn-289 in 1947, showed no scales on the terminal growth of either 1948 or 1949. The owner reported that previous to 1947 scale had been so prevalent in his plantings of lilacs that it had been necessary to do considerable pruning of dead branches each spring, including that of 1947. Nothing of the sort had been done in either 1948 or 1949, indicating that the infestation had been practically eliminated.

**Investigations of Materials Which Promise Value in Insect Control.** (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.)

*Effect of Synergized Rotenone-Pyrethrum on Mexican Bean Beetle*.—Three applications to string beans of dusts containing 0.25 percent rotenone and 0.05 percent pyrethrins with 0.5 percent piperonyl cyclonene or n-propyl isomer reduced damage to bean foliage by the Mexican bean beetle by 82 percent during the most active period, and by 91 to 94 percent for the season. A dust containing 0.12 percent pyrethrins and 0.75 percent piperonyl cyclonene was less effective.

*Insecticides for Squash Borer Control*.—The natural infestation of squash borer in the experimental plantings was 5.94 borers per vine, and the greatest infestation was in the Buttercup variety. Under these conditions the most effective insecticidal treatment was spraying with 50 percent methoxychlor wettable

powder at the rate of 3 pounds in 100 gallons of water. Synergized pyrethrum-rotenone dust and 5 percent chlordane dust were reasonably effective, but the chlordane caused injury to the foliage of the younger plants. Parathion powder as a spray and tetraethyl pyrophosphate as a dust did not have sufficient residual action to give protection between treatments made at weekly intervals.

*Control of Cabbage Maggot*—In the experimental planting in 1949, 65 percent of the cabbage and cauliflower plants were commercially injured by the cabbage maggot. There was no outstanding difference in the infestation on cabbage and cauliflower.

When the insecticides were applied as soon as the first eggs were found and one week later, if repeated, the following dusts gave 95 percent or better protection against commercial injury: 5 percent chlordane dust—1 and 2 applications; 3 percent chlordane dust—1 and 2 applications; 1.5 percent Lindane dust—2 applications.

From a practical standpoint, the 3 percent chlordane dust was as effective as the 5 percent dust, but 1 percent chlordane dust was unsatisfactory and permitted 50 percent commercial injury on cabbage.

Excellent control was also obtained from a suspension of 40 percent chlordane wettable powder at the rate of 4 pounds in 100 gallons of water applied by soaking the plants at transplanting with  $\frac{1}{2}$  cupful to each plant and by dipping the roots of each plant in the suspension when transplanting. Chlordane applied by this method appeared to be as satisfactory as corrosive sublimate used in the same manner.

Observations on commercial farms indicated that chlordane dust, to be effective, must be applied when the first eggs are laid or must be washed around the roots of the plant before the maggots hatch.

*Contamination of Root Vegetables by Soil Treatment with Insecticides*.—Potatoes, carrots, and onions grown in soil treated with chlordane, benzene hexachloride, and pure gamma isomer of BHC (Lindane) in both 1948 and 1949 were tested for taste contamination.

About twice as many tasters detected off-flavor in potatoes grown in soils treated with BHC in 1949 as in those grown in soil treated in 1948.

No taste contamination was observed in potatoes grown in soil treated in 1948 with dosages of either 2 pounds or 5 pounds actual chlordane per acre. Similar treatments in 1949 produced slight to moderate off-flavor in potatoes and in carrots. No practical taste contamination was observed in carrots grown in soil treated with chlordane in 1948. Onions, radishes, turnips, parsnips, and Swiss chard were not contaminated by any soil treatment.

The greatest off-flavor was observed in fried potatoes, considerable in boiled potatoes, and the least in baked potatoes. Pure gamma isomer of BHC at the rate of  $\frac{1}{4}$  pound actual Lindane per acre caused as much off-flavor as regular BHC 12 percent gamma at the rate of 2 pounds per acre when tested both one and two years after treatment. All of the soil insecticides failed to prevent severe injury by cabbage maggot to purple top turnips grown in treated soil.

*Control of Onion Thrips*. (A. I. Bourne.) The protracted drought from early June throughout the rest of the growing season, coupled with continuous hot weather, furnished conditions almost ideal for thrips development. Conditions could scarcely have been more favorable for the insects had they been reared in constant-temperature tanks. Throughout the Connecticut Valley the infestation began early, built up rapidly, and by late June had reached one of the highest peaks in recent years. Many fields of set onions were heavily attacked and in

some cases seriously damaged. Many growers were forced to take measures to protect their fields. Those who had equipment for application of weed killers utilized this equipment for thrips control, with good success. Several growers used parathion, 15 percent wettable powder at 1 pound per 100 gallons, and reported excellent control, superior to results from the use of nicotine.

In field tests for control of thrips on set onions, derris, DDT, Ryanex spray concentrate, parathion (25 percent wettable powder), chlordane, and Black Leaf 40 were applied as sprays. The following dusts were also applied: 1 percent DDT dust, Isotox 10 (a 1 percent high gamma BHC dust), and a 1 percent parathion dust. Triton X-1956 was used as a wetting agent for all the sprays except Black Leaf 40, which was combined with Pine Tar soap. Following thorough application, all these materials gave practically a perfect initial kill. DDT, chlordane, and parathion, of the sprays, gave outstanding residual action, allowing little or no reinfestation during a 7-day period. Derris gave nearly as long protection, but the nicotine sulfate and Ryanex were less effective in their residual effects. Parathion and DDT dusts and the high gamma BHC dust maintained a high degree of protection for at least 7 days. The parathion spray and dust also killed crickets and other species of insects which chanced to be present in the plots at time of application.

**Insecticides for the Control of the European Corn Borer.** (A. I. Bourne.) Following a very mild winter with no period of very low temperature, there was little or no evidence of any winter mortality of larvae. There was a fairly heavy carry-over of larvae from a rather sizable second brood, especially in southeastern Massachusetts and in the lower Connecticut Valley.

First spring pupation was noted in early May, but light and infrequent rain, with much cold weather during the month, slowed development and 50 percent pupation was only reached the last week of May, following a  $1\frac{1}{2}$  inch rain.

First larval appearance was noted on June 10, in the central Connecticut Valley area. The first spray and dust application to experimental plots was made June 13. Three applications were made at 7-day intervals. There was practically no rain during the entire month of June; therefore no interference with the spray or dust program. The infestation in the experimental plots proved to be of only light to medium intensity.

Larval abundance in terms of tassel breakage was as follows: In sprayed plots, following DDT, parathion, and Ryanex, 98-99 percent of the plants were clean, and following derris, 95-96 percent of the tassels were uninfested; in the dusted plots, 97-100 percent of the plants were clean; while in the unsprayed checks, 52 percent of the tassels showed no breakage.

Yield records of harvested corn showed 98-99 percent of the corn in the sprayed plots and 97-98 percent in the dusted plots free from insect injury, compared with 73 percent of the ears in the check plots. In terms of marketable corn, 90-91 percent of the crop in treated plots was of marketable quality, while in the untreated checks only 65 percent of the total yield was of salable size and quality.

**The Value of Control Measures to Supplement the Standard Spray Program for Apple Pests in Massachusetts.** (A. I. Bourne, in cooperation with the Departments of Pomology and Plant Pathology.) Dormant application of DN-289 and late delayed dormant application of a tank mix Superior type oil with blood albumen emulsifier (when 2 or 3 outer leaves of blossom clusters had turned back) were made on Baldwin and McIntosh for control of aphids and red mite. On the unsprayed checks, Baldwins showed 50 aphids per 50 buds, and McIntosh 235. No living aphids were found to have hatched on trees sprayed with the



dormant dinitro and no living aphids were found on the trees given Superior oil. The red mite in this block was too light and scattering to furnish material for a real test.

Superior oil tank mix emulsion, using 1 gallon of the oil to 100 gallons of water, was applied to McIntosh and Baldwin when the fruit buds were in the "pink" stage of development. No trace of foliage burning or distortion of the leaves was noted.

Tolerance tests of parathion (25 percent wettable powder) at one half pound per 100 gallons were made in the pink, calyx, and 1st cover sprays on Baldwin and McIntosh. Parathion was combined with Kolofog, T.A.G., and the Fermate-wettable sulfur combination. General and rather severe injury to foliage of McIntosh was noted following the pink application, especially where parathion was combined with Kolofog or the Fermate-wettable sulfur. Slightly less damage was noted following the combination with T.A.G. Very little evidence of injury could be found on Baldwins. If any occurred, it was indistinguishable from the frost injury to the foliage, which was very general on all the Baldwin trees.

In the Butcher Block, parathion (15 percent wettable powder) at 1 pound per 100 gallons, with the Fermate-wettable sulfur combination as a fungicide, was applied in calyx and 1st cover sprays to three full-grown McIntosh trees. Trees No. 1 and 2 were sprayed in the calyx; trees 2 and 3 in the 1st cover. No evidence of foliage injury was noted, either on the trees receiving a single application or on the one receiving both.

Methoxychlor (Marlate), DDT, and Rothane (DDD) were applied in a full schedule beginning with the calyx, in a test of their cooperative value against the major apple pests. All three materials were used at the rate of 2 pounds (50 percent wettable powder) plus lead arsenate 2 pounds, with the standard fungicide combination of Fermate ( $\frac{1}{2}$  pound) and wettable sulfur (half dosage). The record of McIntosh at harvest showed both methoxychlor and DDT very effective against curculio and noticeably superior to Rothane. Curculio injury in the first two plots was held to 3.1 and 3.5 percent respectively, while 9 percent of the apples showed curculio scars following Rothane. Following methoxychlor, 1.7 percent of the fruit showed codling moth injury, with DDT holding the pest to 0.9 percent damage, and Rothane holding it to 2.6 percent injury. Against codling moth, therefore, all three materials gave excellent protection and were of approximately equal value. No leafroller or apple maggot damage was noted. Red bug damage was practically the same in all three plots and ranged from 3 to 4 percent. Advancing the application of these materials to the pink spray would undoubtedly be desirable for the control of red bugs and other plant bugs. There was practically no scab on the fruit in the entire orchard.

**Potato Spraying Experiments.** (A. I. Bourne.) The experimental plots were planted May 9 to the Green Mountain variety. Rainfall was somewhat light through May and growth was slowed somewhat, although progress was steady. The plots were first sprayed on June 14 when the plants were about 4 to 6 inches high. Fourteen applications were made at approximately weekly intervals up to September 15, when the plants were very well matured and very little new growth was evident. The late applications (of fungicide only) were made to protect new growth from late blight. Bordeaux 10-5-100 was the fungicide used. DDT was added in applications June 12, 23, and 29 for first brood flea beetles and tarnished plant bugs, and in applications of July 14, 20, 27, and August 8 for second brood flea beetles.

Field counts of relative injury to foliage by flea beetles indicated the effectiveness of all forms of DDT used. Counts on June 28 of leaf perforations by first brood beetles showed 240 per leaf on foliage sprayed with Bordeaux alone, 18 per leaf following one application of a 20 percent DDT emulsion, 32 per leaf following DDT 25 percent emulsion, and 20 per leaf following DDT 50 percent wettable powder.

Samples of terminal clusters taken at the outset of the second brood flea beetles before application of DDT showed 69.3 perforations per cluster throughout the field. One application of DDT, reduced the injury to 11.8-12.0 perforations per cluster following the DDT emulsions and 7.8 perforations per cluster following DDT wettable powder.

Yield records in the various test plots still further reflected the value of DDT applications. While the crop was lighter than normal as a result of the drought throughout the entire summer, yields were consistently higher where 25 percent DDT emulsion or DDT wettable powder was applied than following the use of Bordeaux alone.

Field tests on a farm in Hadley against a very heavy outbreak of potato aphids showed that neither DDT emulsion nor nicotine sulfate gave an immediate kill high enough to prevent serious damage. Application of 15 percent parathion at 1 pound per 100 gallons or TEPP at one fourth pint per 100 gallons gave very speedy and almost complete kill; in fact, practically eliminated the aphids.

**Biology and Control of the Celery Plant Bug.** (W. D. Whitcomb, W. J. Garland' and C. S. Hood, Waltham.) In 1949, the first celery plant bugs were found in the experimental plantings on June 24, when 10 to 30 percent of the plants were lightly infested. The plant bug continued to be present in small numbers only, and damage to untreated plants did not become serious. Under these conditions all insecticides gave practical control, the most satisfactory being DDT and parathion as sprays and rotenone-pyrethrins plus a synergist as dusts.

Analyses again showed excessive residue of DDT on leaves 27 and 28 days after application even though about 2 inches of water was applied by sprinkler during the period. This ranged from 12 to 14 p.p.m. where 50 percent DDT at the rate of 1 pound per 100 gallons was applied, to 22.7 p.p.m. where a 3 percent dust was used. Because of the general use of celery leaves for seasoning and garnishing, other effective materials must be used in place of DDT.

**Control of Plum Curculio in Apples.** (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) In 1949, continued high temperatures during the active period of the plum curculio concentrated the attack of this pest and favored good control where timely sprays were applied. Winter survival of the beetle was high, and there was a large population throughout the State.

In the experimental orchard a block of trees which received an ineffective treatment too late had 66.79 percent of the fruit damaged and 74.47 percent fell before it matured.

The outstanding insecticide used in these experiments was methoxychlor, an analog of DDT. When used alone as a 50 percent wettable powder at the rate of 3 pounds per 100 gallons of water, or at the rate of 2 pounds combined with 2 pounds of lead arsenate per 100 gallons, it produced 98 + percent uninjured fruit. The combination of 50 percent DDT powder 2 pounds plus lead arsenate 2 pounds per 100 gallons of water also gave 98 percent protection, and again justified its recommendation in the apple spray schedules. A new compound, Aldrin, gave good control of the curculio at 3 pounds of 25 percent powder in 100 gallons, but failed to protect against codling moth and red-banded leafroller.

Other treatments when used at the following amounts in 100 gallons of spray

were slightly less effective: 50 percent chlordane wettable powder 3 pounds; lead arsenate 2 pounds plus 50 percent DDD (Rothane) wettable powder 2 pounds; 50 percent chlordane wettable powder 2 pounds plus 50 percent DDT powder 2 pounds; 25 percent parathion  $\frac{3}{4}$  pound and 15 percent parathion (safened)  $1\frac{1}{2}$  pounds. Parathion in each form caused injury to leaves and fruit.

Results of these studies were reported and published in the Annual Reports of the Massachusetts Fruit Growers Association, the Maine Pomological Society, and the New York State Horticultural Society.

**Apple Maggot Emergence.** (W. D. Whitcomb, Waltham.) The number of apple maggot flies which emerged from the hibernation cages at Waltham in 1949 was the smallest recorded in the past twenty-five years, being only 10 percent of the expected number. This small emergence was apparently due to the drought and lack of sufficient moisture in the soil to enable the insects to pupate and emerge as flies.

The first fly was collected June 22 but 25 percent of them did not emerge until July 11. The greatest number appeared July 16 to 19, and the last on August 5. By digging up the insects in late August after natural emergence was completed, it was found that approximately 5 percent of the pupae were alive and were prepared to emerge in 1950.

Emergence cages placed under sprayed apple trees showed that many of the flies were killed by the spray residue as they emerged from the soil. The results in 1949 were:

<i>Sprayed Trees</i>	<i>Percent Flies Dead</i>
<i>Material and Amount in 100 Gal.</i>	<i>24 Hours After Emerging</i>
1—Lead Arsenate, 2 lb. + 50 DDT 2 lb.	66.7
2—15 Parathion, $1\frac{1}{2}$ lb.	32.8
3—50 Methoxychlor, 3 lb.	66.7
4—25 Aldrin, 3 lb.	25.0

**Biology and Control of Grape Cane Girdler.** (W. D. Whitcomb and C. S. Hood, Waltham.) Activity of the grape cane girdler in 1949 was concentrated because of high temperatures into the period from May 15 to June 15. Control by spraying was effective for 5 to 7 days while the new canes were growing 12 to 15 inches. During the first part of the active period when the beetles were moving into the vines from hibernation, spraying reduced the number of girdled canes 80 to 95 percent. The most effective formulas were: lead arsenate 2 pounds plus 50 percent DDT 2 pounds, and 25 percent parathion 1 pound, per 100 gallons of water. A dust containing Lindane, DDT, and sulfur was effective for 7 days or until washed off by rain.

Chlordane 50 percent wettable powder at the rate of 4 pounds per 100 gallons of water caused severe foliage injury and its use was abandoned after one application.

In all experiments, spraying prevented significant injury to the vines or grapes.

**Biology and Control of Common Red Spider on Greenhouse Plants.** (W. D. Whitcomb, W. J. Garland and C. S. Hood, Waltham.) New miticides were evaluated for the control of the common red spider on greenhouse roses as follows:

- Gearphos (Geary Chem.) — dialkyl nitro aryl thiophosphate
- Arathane (Rohm & Haas) — dinitro capryl phenyl crotonate
- C 854 (Dow) — p-chlorophenyl benzene sulfonate

When these miticides were diluted according to the manufacturers' directions and applied as sprays four times at weekly intervals, all formulations gave excel-



lent protection. Residual action of these miticides following one application was good for two weeks but unsatisfactory for longer periods.

**Study of Euonymus Scale and Its Control.** (W. D. Whitcomb and W. W. Cantelo, Waltham, in cooperation with the Bartlett Tree Expert Company.) Further studies of the seasonal history of the Euonymus scale showed that the high temperatures in June and July, 1949, enabled this insect to complete its development in 49 days, compared to 63 days in the cooler weather in 1948. In constant-temperature cabinets, the life cycle varied from 40 days at 80° F. to 68 days at 60° F. The maximum number of eggs per female scale was 81 and the greatest number was laid August 24. Crawlers traveled as far as 16 inches and nearly always moved upward. In a natural population there are about five times as many male scales as female, and there are five times as many scales on the leaves as on the stems.

As a dormant spray, regular oil emulsion diluted to 4 percent and Superior oil emulsion at 2 percent gave satisfactory control without injury to the plants. Greater dilutions were not effective from a practical standpoint. Evaluation studies on the crawlers of the summer generation of the scale showed that DDT was more effective than its analogs, DDD, DFDT, or methoxychlor. Effective control of the crawlers in June and August was obtained with the combination of oil emulsion (Volck) 2-100 plus 40 percent nicotine sulfate 1-800, and with 25 percent DDT emulsion (Resitox 25) 1-200. Both of these treatments killed newly settled scales ten days old or less, and the residue prevented crawlers from settling for ten days after application. In this way, one treatment gave protection for about three weeks.

**Materials and Methods Which Promise Value in Control of Insect Pests of Ornamental Shrubs, Shade and Forest Trees, and Forest Products.** (W. B. Becker.)

*Insect Control Tests.*—(With Hydraulic Sprayers.)

Beech aphids: Excellent control was obtained with a 25 percent parathion wettable powder (1 pound per 100 gallons) on cut-leaf and copper beeches.

Butternut lace bugs: Promising control was obtained with a 35 percent tetra ethyl pyrophosphate emulsion (1-2400 by volume); poor control, with a 50 percent DDT wettable powder (2 pounds per 100 gallons).

Imported willow leaf beetle: Promising control was obtained with a 50 percent methoxychlor and also with a 50 percent benzene hexachloride wettable powder (2 pounds per 100 gallons).

Fall webworm: Promising control was obtained with a 25 percent (gamma isomer) benzene hexachloride emulsion (1-800 by volume); excellent control, with a 50 percent methoxychlor wettable powder (2 pounds per 100 gallons).

No plant injury resulted from any of these spray applications.

(With Mist Blowers)—Fall webworm: Excellent control was had with a 50 percent methoxychlor emulsion applied lightly.

(With Small Compressed Air Sprayers)—In preliminary tests in which white pine logs of cord-wood size were thoroughly wetted on all surfaces, excellent prevention of infestation by sawyers, flat headed borers, bark weevils, and ambrosia and bark beetles resulted all season long from single applications of  $\frac{1}{2}$  and 1 percent (gamma isomer) benzene hexachloride emulsions and oil solutions. Results with 1 and 2 percent DDT emulsions and oil solutions were erratic, ranging from poor to fair.

*Spray Injury Tests.*—(With Hydraulic Sprayers)—The following insecticides caused no injury to many different broad-leaved deciduous or needle-leaved plants sprayed at the indicated concentrations and weather conditions.

**Dormant Applications:** Shell's Helix Superior Oil No. 22 for tank mix (2-100 by volume) plus  $\frac{1}{2}$  pound blood albumen: air temperature 42°-45° F., humidity 30-38 percent; Pratt's Scalecide (1-25): air temperature 51°-57° F., humidity 23-26 percent; Sunoco Spray Oil (1-30): air temperature 57°-58° F., humidity 26-23 percent.

**Early June Applications:** Du Pont's 50 percent methoxychlor wettable powder (Marlate 50) (2 pounds per 100 gallons): air temperature 53° F., sunny and windy; Du Pont's 50 percent benzene hexachloride wettable powder (Lexone 50) (2 pounds per 100 gallons): air temperature 53°-60° F., humidity 48 percent; American Cyanamid's 25 percent parathion wettable powder (Thiophos 3422) (1 pound per 100 gallons): air temperature 60°-62° F., humidity 48-45 percent.

**Late July and Early August Applications:** Niagara's 35 percent tetraethylpyrophosphate emulsion (Hexide 200) (1-2400): air temperature 83° F., humidity 52 percent (test limited to cut-leaf and copper beeches) Niagara's 25 percent (gamma isomer) benzene hexachloride emulsion (Gam-Kil 25) (1-800): air temperature 77°-89° F., humidity 71-49 percent.

Some degree of plant injury resulted from applications of the following materials at the given weather conditions.

**June Applications:** Shell's Helix Superior Oil No. 22 for tank mix 1-100 by volume) plus  $\frac{1}{2}$  pound blood albumen: air temperature 84° F., humidity 56 percent. Of many kinds of trees sprayed with this oil, sugar maple and cherry trees sometimes, but not always, showed spray injury. Dow's dinitro-orthocyclohexyl-phenol (DN-111) ( $1\frac{1}{4}$  pounds per 100 gallons): air temperature 66°-70° F., humidity 48 percent. Once again this material injured many kinds of broad-leaved deciduous shade trees but did not harm any needle-leaved plants.

**Sprays to Prevent Scolytid Infestation of Elm Logs.** (W. B. Becker.) In small-scale tests, single applications of 1 percent DDT, methoxychlor, Toxaphene, chlordane, and benzene hexachloride (gamma isomer) spray emulsions all gave excellent protection all season long against infestation by elm bark beetles. *Scolytus multistriatus* Marsham outnumbered *Hylurgopinus rufipes* (Eich.) in the unsprayed checks by over two to one.

**Sprays to Kill Scolytids Breeding in Elm Logs.** (W. B. Becker.) In small-scale tests, elm logs that were infested with elm bark beetles were sprayed approximately two weeks before beetles emergence. One percent DDT, chlordane, and Toxaphene, and 0.2 to 1.0 percent (gamma isomer) benzene hexachloride showed much promise in preventing beetle emergence or killing those beetles which did emerge before they could breed in freshly cut unsprayed elm logs which were available to them. A 1 percent methoxychlor emulsion spray gave poor results in this test.

**Spraying to Prevent Twig Feeding by the Smaller European Elm Bark Beetle.** (W. B. Becker.) Methoxychlor emulsions (1 and 2 percent, especially the latter) gave good, long-lasting protection against twig feeding, approximately equivalent to that obtained with DDT emulsions of equal concentrations. Low branches were sprayed at close range with small compressed air sprayers, and tall trees were sprayed with a large power sprayer. In tall trees, twig samples were collected at different heights for beetle feeding tests (the same as described in Mass. Agr. Expt. Sta. Bul. 441:41-42, 1947).

**Spraying Tests with DDT for Dutch Elm Disease Control.** (W. B. Becker.) The site chosen for this test was one where elm logs had been piled and left untreated over a period of many years, where elm bark beetles bred in large numbers,

and where Dutch elm disease had been killing surrounding elms at a particularly rapid rate. One group of elms was sprayed with large amounts of DDT by a mist blower (2 to 5 pounds DDT technical per tree, depending upon its size). A second lot of elms was sprayed lightly by the municipality, reportedly two to four times a year (perhaps about 1/16 of a pound of DDT technical per tree at each application). A third group of trees in a ravine could not be reached with the spraying equipment and was used as an unsprayed check. At the end of the first season, not one of the sprayed or unsprayed elms in the test showed any symptoms of Dutch elm disease. It is suspected that the municipality's newly instituted Dutch elm disease sanitation program in the vicinity influenced the results. It is hoped that this spraying test will continue for several years and that additional tests can be started at other places.

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## FEED AND FERTILIZER CONTROL SERVICES

John W. Kuzmeski in Charge

The feed, fertilizer, and milk testing laws are administered as one service and the operations of each, with the exception of the milk testing law, are reported in annual bulletins.

Under the milk testing law 4,652 pieces of Babcock glassware were calibrated and 205 certificates of proficiency in testing were issued. All milk depots and milk inspection laboratories in the Commonwealth were visited at least once to check apparatus and general conduct of the work.

In addition to the regulatory work, the Feed and Fertilizer Control laboratories have examined feeds, fertilizers, and other agricultural materials for citizens of the Commonwealth without charge whenever the results were considered of interest to the general public or to the Control Services.

Considerable work has been done on research projects in cooperation with other departments of the University and Experiment Station. The results of such work are reported by the departments originating the projects.

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## DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

**The Effect of Soluble Salts on Florists' Crops.** (Harold E. White.) Fertilizer materials were applied to carnation plants at three different levels, as follows: Series A: Ammonium sulfate 1.50, nitrate of soda 2.25, and muriate of potash 0.25 pounds per 100 square feet bench area. Series B: Ammonium sulfate 2.50, nitrate of soda 3.25, and muriate of potash 0.75 pounds. Series C: Ammonium sulfate 4.00, nitrate of soda 5.0, and muriate of potash 1.0 pound. The fertilizers were applied in four doses one to each plot in September, October, November, and March. Plot treatments were replicated three times with 56 plants per plot, and included four varieties of carnations.

The soluble salts increased in the soil from  $34 \times 10^{-5}$  mhos to  $46 \times 10^{-5}$  mhos for Series A,  $55 \times 10^{-5}$  mhos for Series B, and  $86 \times 10^{-5}$  mhos for Series C. The plants showed no unfavorable effects from any of the fertilizer treatments. The number of flowers produced was 723 in Series A, 741 in Series B, and 753 in Series C. No difference was noted in the quality or grades of flowers produced, and the splitting of the blooms did not vary.

Snapdragon plants treated in the same manner as carnations showed no symptoms of plant injury but did show a decrease in flower production at the highest fertilizer level. Flower production for the season was 858 blooms for Series A,



827 for Series B, and 661 for Series C. The quality and grades of blooms were not significantly affected by the treatments.

Soluble salt readings were much higher for the snapdragon soils than for the carnation soils. Solu-bridge soluble salt readings increased from  $35 \times 10^{-5}$  mhos to  $100 \times 10^{-5}$  mhos for Series A,  $110 \times 10^{-5}$  mhos for Series B, and  $130 \times 10^{-5}$  mhos for Series C. These data show that high soluble salt accumulation from fertilizers in soil will affect flower production of snapdragons, even though there may be no visible plant symptoms of injury from the salts.

**The Effect of Soil Temperature on Flowering of Carnations.** (Harold E. White) Carnation plants were grown in heated soil, maintained at a temperature of  $60^{\circ}$ - $62^{\circ}$  F. from September through April, in comparison with unheated greenhouse soil which had a temperature of about  $50^{\circ}$ - $52^{\circ}$ . Soil temperature in the heated plot was controlled by a lead-covered electric heating cable buried in the soil and regulated by a thermostat. Temperature records of the soil were kept by a recording clock thermometer. Sixteen different varieties of carnations were used in the test, with 252 plants each in heated and unheated soil.

No significant differences were observed in growth or flowering of the plants, in quality of the blooms, or in splitting of calyxes of the flowers in heated and unheated soils. During the season 1561 blooms were produced in the unheated soil plot as compared to 1577 blooms in the heated plot.

**Chemical Treatment of Soils for Control of Root Nematode.** (Harold E. White.) Preliminary studies with Begonias in nematode-infested soils treated with benzene hexachloride or chlordane emulsion indicate that these chemicals are worthy of further investigation for control of root nematodes.

Nematode-infested soils from the greenhouse were treated with a wettable powder containing benzene hexachloride 12 percent gamma isomer at rate of 10, 15, 20, and 25 grams per 6-inch Azalea pot of soil. The powder was thoroughly mixed with the soil which was then kept well watered for a period of two weeks. In another series, pots of soils were treated with solutions of chlordane emulsion 20 percent at dosage rates of 10, 20, 30, and 50 cubic centimeters per pot. Nematode-infested soils heat-treated at  $180^{\circ}$ - $200^{\circ}$ F. and untreated soils were used as check treatments. A period of two weeks was allowed to elapse before seedling Begonias were transplanted to the differently treated soils. At the end of two months the plants were carefully removed from the pots and the roots washed free of soil with water.

Top growth of the plants was retarded and roots of the plants showed varied degrees of injury at all concentrations used in the treatments with benzene hexachloride and chlordane. This effect on plant growth was more noticeable with chlordane than with benzene hexachloride and in both cases was more severe as the dosage was increased. With benzene hexachloride the 10 and 15 gram treatments did not injure the plant roots or retard top growth too severely.

No nematode galls were found on the plants treated with the two chemicals or on roots of plants in the heat-treated soil, but plants in untreated soils were heavily infested with nematode galls.

Roots containing nematode galls were mixed into the soils before treatment with the chemicals, and on examination at the end of the experiment were found to have been well decomposed in comparison with infested roots in the untreated soil.

Whether nematode-infested soils can be treated successfully with benzene hexachloride or chlordane within limits of toxic effect to the plants would have to be further determined.

**The Effect of Nutrient Elements and Light on Carnations.** (N. W. Butterfield, F. J. Campbell, Waltham.) The experiments on nutrients were a failure because of the severe loss of plants by bacterial wilt in most of the plots. With the remaining plots particularly high in potassium, there was a queer mottling in the leaves. It is possible that the high potassium was causing a deficiency of magnesium. More studies are being carried out on this phase of the problem this year.

During the past year samples of soil were collected each month on three varieties—Northland, William Sim, and Virginia—from fifteen growers. Records were kept of production and amounts of fertilizer used. Data for the year are not complete but there are a few points of interest at this time. The soils were tested monthly for soluble salts, pH, N, P, K, and Ca, and in the soils of some growers soluble salts were found to be above the maximum range of 100 (International system). The growers were notified of this condition, and those who leached their soils reported tremendous increases in growth.

The analyses of calcium and potash were run on the flame photometer at the Experiment Station at Amherst. The lowest calcium level reported was 750 p.p.m. and the highest 4,000 p.p.m. It is believed that the range for optimum growth should be at 2000-2500 p.p.m. The potash ran from 40 to 600 p.p.m. It is believed that the optimum should be from 200 to 300 p.p.m. Much will depend on the nitrate level and the age of the plants.

The tests for nitrate and phosphorus were run colorimetrically on the new Fisher neofluorophotometer. This instrument proved an accurate and rapid means for determination of these two elements.

*Gypsum versus Lime For Florists' Crops.* Of special interest to growers were the preliminary results of an experiment on the use of gypsum to correct the low calcium when high pH prevails in the soil.

In the past, a grower hesitated to add lime if the pH was above 6.5 and the soil had a low calcium condition. During the past year gypsum has been recommended when this condition existed. As a result of preliminary work it was found that two applications of gypsum ( $\text{CaSO}_4$ ) increased the soluble salts nearly twice over what they were in the check. This is not a serious problem, for sulfates leach out rather readily, this treatment being advised when the tests showed high soluble salts.

The normal soil (check) had 1500 p.p.m. of calcium. When two applications each of 3 pounds of ground limestone to 100 square feet were added, the calcium was increased to 1800 p.p.m. When two applications each of 3 pounds of gypsum were added, the calcium was increased to 2400 p.p.m. The tests were made on the flame photometer at the Experiment Station at Amherst.

The soil for the check plot had a pH reaction of 5.5. At the end of the year the soil receiving the ground limestone had a pH of 6.3, and the soil receiving the gypsum 5.05 pH. This showed that gypsum had a depressing effect on the pH. The calcium was taken up by the plants, leaving the sulfate radical to combine with the hydrogen to increase the acidity.

**The Effect of Mulches on Carnations.** (F. J. Campbell, Waltham.) Four mulches—corn cobs, peanut shells, sawdust, and manure—were applied to two varieties of carnations. The treatments were randomized in three different benches with a check plot in each bench. The object of this experiment was to study the effect of mulches on pH, production, general vigor, disease, and on nutrients and the soluble salt conditions throughout the year.

The pH was lower for all mulched plots than for the check; and, more specifically, the pH of the manure plots was lower than the pH of the sawdust, corn-cob, or peanut-shell plots.

Some mulches had a tendency to increase the soluble salts of the soil. This was particularly true of manure. At the end of the season the soluble salt content of the manure plots was nearly double that of the other mulched plots.

Some mulches have the tendency to increase soil friability or porosity. The plots mulched with corn cobs seemed to have the greatest increase in porosity. To a lesser degree, sawdust was next and then peanut shells in order of degree of porosity.

There seemed to be no significant difference in production for the different mulches, and all plots, including the check, seemed to require the same amount of water for optimum growth. It is generally believed that mulches help to conserve water, but this did not prove to be true in this experiment.

Some growers hesitate to mulch carnations for fear that stem diseases will be increased. The losses were extremely low in all these treatments. However, the plants were set particularly high.

**The Effect of Chemicals on Carnation Pathogens.** (N. W. Butterfield, Waltham.) During the past few years carnation growers in this area have experienced heavy losses of young plants, and efforts to control diseases have failed. It was hoped that some of the new chemicals would be effective, especially in controlling surface-borne diseases such as *Rhizoctonia*.

Six chemical treatments, consisting of Fermate, Phygon XL, Fulex A, Fulex B, and Fulex A and B, and a check were used in the experiment. Cuttings of the variety Northland were obtained from a reliable grower and treated with the chemicals except Fulex A, which was known to be injurious to cuttings. Cuttings rooted well with all treatments.

The young rooted cuttings were treated immediately after being planted in Vita bands and received four additional treatments in the bands. The six treatments were partially randomized in six different benches, and on July 21, 1949, the young cuttings were planted in the benches and immediately treated. They received three additional treatments in the benches before cool nights came in September.

The results this year were negative. There was considerable variation between the same treatment in the different benches. For example, losses in one bench for the check were 3 percent, whereas in another the losses were 55.1 percent. The differences in losses for the same treatment in different benches were less with Fermate and Phygon XL.

There was no consistent indication that chemical soil treatment arrested or controlled the fungus *Rhizoctonia*. On the basis of this year's results, growers are strongly urged not to purchase expensive chemicals for controlling carnation pathogens. Better cultural practices, such as sterilization of propagating medium, better selection of cuttings, and sterilization of old soils are being stressed.

**Effect of Light on Prolonged Chrysanthemum Bloom and Change of Flowering Habit.** (N. W. Butterfield, Waltham.) Some varieties of chrysanthemums have a tendency to produce very tight clusters of flowers, a condition that retailers do not like for their design work. With some varieties, this condition may be changed by variations of long and short day treatment.

The varieties Gold Coast, Yellow Fellow, Masterpiece, Bittersweet, and Early Godfrey were obtained from a grower and planted July 2, 1949. Each variety received the following treatment: (1) Check or normal light; (2) Plants shaded from 5 p.m. to 8 a.m. August 12 to October 6; (3) Plants shaded between 5 p.m. and 8 p.m. August 12 to 19 and lighted to 10:30 p.m. from August 19 to September 15; (4) Plants lighted to 10:30 p.m. from August 12 to September 15, followed by normal light to flowering.



Gold Coast, Masterpiece, and Bittersweet had longer laterals and more flowers per spray from treatment 3. Yellow Fellow and Early Godfrey showed no response to this treatment. Therefore, it will be necessary to experiment with each variety showing a different type of inflorescence.

**Tulip Trials.** (F. J. Campbell, Waltham.) During the fall of 1949, approximately 16,000 tulip bulbs representing ninety-six varieties were planted in eighteen beds.

In each of nine beds the following six varieties were planted: Dido, Princess Elizabeth, Blue Perfection, Glacier, Mrs. John T. Sheepers, and Eclipse. Three planting depths,<sup>1</sup> 6, 8, and 10 inches, were triplicated, and two treatments for fire blight were employed. Each planting depth included a check, a treatment with Parzate, and a treatment with Fermate. The chemicals were dusted on the bulbs immediately before planting. In the spring season of 1950 there was little or no difference between the 6 and 8 inch depth of planting. However, the emergence, date of bloom, and height of the bulbs in the 10 inch bed were greatly retarded.

The remaining nine beds were employed as a varietal trial for tulips grown under New England conditions. Here, the planting depth for ninety varieties averaged 6 inches. Darwin, Cottage, Breeder, Double, and Parrot tulips were represented.

A few sections of the varietal trials were sprayed with 2, 4-D, applied to one-half of each variety after the tulips had finished blooming. An inactivator was applied three hours after the 2, 4-D treatment.

It is planned to let the bulbs remain in the ground for at least two years in order to determine whether the treatments for fire blight and the 2, 4-D treatments are beneficial or detrimental, and to determine the degree of vigor of each variety.

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## DEPARTMENT OF FOOD TECHNOLOGY

C. R. Fellers in Charge

**Processing Methods for Pasteurized Fresh Cucumber Pickles.** (W. B. Esselen, Jr., E. E. Anderson, L. F. Ruder, E. A. Nebesky, and N. Glazier.) This investigation was initiated to study the degree of pasteurization or heat treatment required to prevent spoilage of pasteurized fresh cucumber pickles. A large volume of these pickles is packed at present. The general procedure consists of packing washed raw cucumbers into jars, adding a low-acid, low-salt brine with appropriate flavoring agents, sealing, and pasteurizing the jars at temperatures ranging from 165° to 190°F. From time to time spoilage has been encountered with this product. Upon its completion this study should provide further information on factors which influence the process requirements of this type of pickle as well as additional heat penetration and microbiological data to serve as a guide in formulating adequate pasteurization procedures.

During the 1949 season tests were made on 11 experimental packs of fresh cucumber pickles put up in the laboratory as well as 9 packs put up under commercial conditions in three different pickle plants located in this area. Additional heat-penetration tests were made on gallon jars of pickles and on quart jars at various processing temperatures. These packs of pickles had an equalized acidity of from 0.4 to 0.6 percent acetic acid.

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<sup>1</sup> Depth of planting is the distance from the top of the bulb to the surface of the soil.

*Process Time Requirements.*—Two characteristic types of spoilage have been observed. In most cases spoilage that occurred within three weeks of packing was characterized by vigorous gas production and cloudiness. Much of the spoilage that developed after three weeks was characterized by the formation of a white sediment in the bottom of the jar and occasional clouding of the brine. Jars of pickles showing this type of spoilage have been found from time to time on store shelves. The data obtained from the experimental packs indicate that a process equivalent in severity to at least 0.2 minutes actual holding time at 212° F. is necessary to prevent spoilage. When the pasteurization is done at 180° to 185° F. it would appear that these requirements will be met if a brine temperature of 175° to 180° F. is reached in the lower central part of the jar.

*Destruction of Enzymes.*—The available data indicate that the enzyme peroxidase in fresh pickles is more heat-resistant than spoilage organisms which are encountered. Preliminary tests have indicated that the thermal destruction of the enzyme indophenol oxidase may more closely parallel the destruction of spoilage organisms than does the destruction of peroxidase.

*Development of Off-Flavor.*—Observations on the experimental packs of pickles, after seven months storage, indicated that off- or stale flavors developed in pickles given the shorter process times. The process times necessary to prevent the development of these off-flavors tended to approximate the process times required to prevent microbial spoilage in some cases; however, the results were somewhat erratic. The off-flavors encountered resembled those observed in pickles to which a peroxidase enzyme preparation was added or the off- or hay-like flavor that develops in inadequately blanched dehydrated and frozen vegetables. Therefore, it is suspected that this off-flavor in pickles may be caused by enzymes which were not destroyed during the process.

*Bacteriological Findings.*—Limited observations on the washing procedures employed in commercial pickle plants have shown that, while these procedures are effective in removing physical dirt such as soil and sand, they are not effective from a bacteriological standpoint. Rather than reducing the bacteria load, such washing and soaking methods tend to recontaminate and increase the bacteria load in pickles. The practical significance of this factor in relation to processing requirements remains to be determined.

As has been found by other investigators, the processing treatments given fresh cucumber pickles do not completely sterilize the jar contents. In the above tests it was found that after a process of 15 to 25 minutes at 180° F. the bacteria count was reduced to about 20 to 300 organisms per milliliter of brine in the jars. This appeared to be a residual level which was not significantly reduced by longer process times up to 40 minutes. These residual levels of bacteria counts did not change significantly during storage of the pickles for seven months.

The addition of 20 p.p.m. of mustard oil (allyl isothiocyanate) did not have a significant effect on the process requirements of fresh cucumber pickles.

*Heat Resistance of Microorganisms Isolated from Jars of Spoiled Pickles.*—Preliminary tests indicate that the more heat-resistant spoilage organisms isolated from pickles have a heat resistance approximating 0.2 minutes at 212° F. This is in good agreement with the observed process requirements of the pickles based on heat penetration and spoilage tests.

*Studies on the Peroxidase in Acid Foods.* (W. B. Esselen, Jr., E. A. Nebesky, and C. R. Fellers.)

*Effect of Peroxidase on the Quality of Processed Cucumber Pure.*—Studies to determine the effect of various concentrations of peroxidase on the quality of

processed packs of puré cucumber pickles stored at various temperatures have been extended. The presence of peroxidase was found to play a role in lowering the quality of the color, flavor, and aroma of processed cucumbers. The effect on quality was recognized by the development of a distinct flat or haylike flavor and aroma along with a bleaching or fading of color. This deterioration was more noticeable with samples containing the greater concentration of peroxidase, and with samples stored at the lower temperature, 35° F., than with similar packs stored for the same period at 100° F.

Although the peroxidase extract obtained in this investigation exhibited strong peroxidase activity, other enzyme systems such as polyphenolase, catalase, phosphatase, ascorbase, and pectinase, which are known to occur in the raw material, were undoubtedly present. Therefore, the deterioration in the processed packs may have been due to the cumulative effect of peroxidase and other respiratory enzymes. However, the high thermostability of peroxidase in comparison with other enzymes suggests the possibility that this enzyme alone may survive the heat treatment and be responsible for deterioration in processed foods.

*Effect of Maturity on Peroxidase Activity.*—Subsequent studies have revealed that the concentration or distribution of peroxidase varied in different lots of the same products. A study was initiated to determine the relationship between maturity and peroxidase activity of fresh pears. The degree of peroxidase activity was determined in representative samples of the fresh fruit and at various stages of maturity from the very green (immature) to ripe, over-ripe, and decayed (excessively over-mature) stages. Investigations were also made to determine the relationship between degree of maturity and peroxidase activity in samples during storage at 70° to 80°F. and 35°F. The peroxidase activity in fresh pears as measured during various stages of maturity varied considerably. The activity was greatest when the pears were very green and decreased only slightly up to the ripe stage but decreased markedly from the ripe to over-ripe and excessively over-ripe stages. The results obtained from determinations of peroxidase activity of fresh pears allowed to ripen during storage at 70° to 80°F. and 35°F. showed that with samples stored at the higher temperature the variation in peroxidase activity during ripening was more significant than with samples stored at 35°F., because of the increased rate of maturation at the higher temperature. In the former case the fruit matured from the very green to the excessively over-ripe stages within a period of 12 days, while in the latter it required six weeks for the fruit to ripen from the very green to the over-ripe stages. Maturity of the pears was determined by visual and organoleptic examination as to color, firmness of texture, and taste. The data obtained are of interest since earlier studies revealed that the thermal destruction time for the peroxidase of various foods increased with increased concentration of the enzyme.

*Peroxidase Activity in Commercially Packed Foods.*—This study was concerned primarily with determining the extent of peroxidase activity in a number of commercially packed acid foods to ascertain whether the processing conditions for these products were sufficient to insure destruction or inhibition of the enzyme systems. A variety of canned fruits (apples, apricots, peaches, pears, fruit cocktail) and a number of cucumber pickle products (Kosher style dill, processed dill, sweet mixed, mustard, chow chow, candied sticks, picklesticks, and piccalilli) obtained from the shelves of local markets and representing a number of manufacturers were investigated. The commercial processing conditions of time and temperature as used for the destruction or inhibition of microorganisms capable of producing deterioration were also sufficient to insure the complete inactivation of the peroxidase system in these foods with the exception of packs of Kosher



style dill and processed dill pickles. The peroxidase was observed to be highly active in representative samples obtained from the former and moderately active in samples obtained from the latter.

**Preservatives for Fresh Cider.** (W. B. Esselen, Jr., and E. E. Anderson.) Experiments were carried out to observe the comparative preservative action of mustard oil (allyl isothiocyanate), sodium benzoate, and sulfur dioxide as preservatives for fresh cider. Freshly expressed McIntosh cider was used. Sulfur dioxide, added in the form of sodium bisulfite, was unsatisfactory as a preservative for fresh cider. In the concentrations used, 200, 500, 750, and 1000 p.p.m. sulfur dioxide, a strong sulfur dioxide flavor was imparted to the cider. Fermentation was prevented by 500 p.p.m., but not by 200 p.p.m. sulfur dioxide. A characteristic flavor could be detected in the cider when concentrations of .08 percent or greater of sodium benzoate or 20 p.p.m. of mustard oil were added. Concentrations of .04 to .06 percent sodium benzoate with 5 to 10 p.p.m. of mustard oil appeared to provide good preservative action without imparting off-flavors to the cider.

**Processing Studies on Home-Canned Asparagus and Beets in Quart Jars.** (Cooperative Project with Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture.) (W. B. Esselen, Jr., W. Averill, and J. Licciardello.) Heat-penetration data were obtained on asparagus cuts and spears, and beets (small whole, quartered, sliced, and diced) in quart jars processed in a pressure canner at 240°F. (10 pounds steam pressure). Overfilling, to the extent that might be encountered in normal home-canning practice did not significantly affect the rate of heat penetration in home canned beets. The data obtained indicate that process times of 40 minutes at 240°F. for asparagus cuts and spears and small whole, quartered, and diced beets and 45 minutes for sliced beets in quart jars should be adequate for these products.

An Experiment Station Bulletin (No. 456) on the processing requirements of home canned baked beans, hominy, and white potatoes, based on work carried on during the past three years, has been prepared.

**Fruit Pie Fillings.** (E. E. Anderson, R. Nielson, and W. B. Esselen, Jr.) The preparation of complete, ready-to-use apple, blueberry, cherry, and peach pie fillings has been investigated. The preparation of such products involves the incorporation of sugar and a suitable thickening agent with the fruit. To date a number of starches and gums have been compared for use as thickening agents. Cornstarch and modified cornstarch in amounts of 1.0 to 2.0 percent were the most satisfactory of the thickening agents studied so far. When starch is used as a thickener in frozen fruit pie fillings it shows marked retrogressive changes on freezing and thawing. However, it performs its function as a thickening agent when the pies are baked.

**Utilization of Mahogany Quahogs.** (C. R. Fellers.) Experimental work has been done on the utilization of mahogany or ocean quahogs. Rich sources of this quahog have recently been located off the New England Coast. A very satisfactory canned chowder can be made from this quahog. This is a totally undeveloped resource of the State.

**Freezing Cultivated Blueberries.** (W. B. Esselen, Jr. in cooperation with J. S. Bailey, Pomology Department.) From time to time complaints have been received that the skins of frozen blueberries may be tough. In variety tests with cultivated blueberries during the 1948 season it was observed that some varieties had tough skins after freezing and storage. In 1949 tests were conducted in an

effort to determine the cause of tough skins on frozen cultivated blueberries. Of the 10 varieties tested some had tough skins and others did not. Varieties which had tough skins in 1948 were not necessarily tough in 1949. Stage of maturity and exposure to bright sunlight after picking did not appear to be related to tough skins. There are reports in the literature that blanching will prevent toughness in blueberry skins by inactivating the enzymes responsible for this change. In 1949 the 10 varieties tested were frozen both blanched and unblanched. In no case did blanching prevent tough skins. Thus, to date, no satisfactory answer is forthcoming as to the cause and control of tough skins in frozen blueberries.

**Use of Home Canning Jars as Containers for Home Freezing.** (W. B. Esselen, Jr., and M. D. Labbee.) Various types of home canning jars have been studied from the standpoint of their suitability as containers for home and locker frozen foods. Freezing rates of glass, tin, and paper containers, of pint size, packed with 10 percent sugar syrup were determined and were found to be similar for all practical purposes. Dry-packed vegetables, meats, and dry and syrup-packed fruits and fruit juices can be frozen successfully in home canning jars without danger of breakage of the container provided adequate headspace is allowed for expansion of syrup-packed products and fruit juices during freezing. Breakage was encountered with brine-packed vegetables. Both round and square pint and quart home canning jars with different types of closures were employed in these tests. From the standpoint of convenience of use and ease of stacking, the two-piece metal lid appeared to be very satisfactory for home freezing. A survey made within the State indicated that people are using home canning jars with apparent success for home freezing.

**Further Aspects of Trimethylamine Formation in Fish.** (D. W. Anderson, Jr., and C. R. Fellers.) Small-mouthed black bass (*Micropterus dolomieu*), pickerel (*Esox niger*), white perch (*Morone americana*) yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigro-maculatus*), sunfish (*Lepomis gibbosus*), eastern golden shiners (*Notemigonus crysoleucas*), and bullheads (*Ameiurus* sp.) were analyzed for trimethylamine and trimethylamine oxide, and all were found to contain small amounts of trimethylamine. The small-mouthed bass, pickerel, white perch, black crappie, sunfish and blue gill were found to contain trimethylamine oxide.

The trimethylamine oxide content of hatchery brown trout (*Salmo trutta fario*) fed a diet containing trimethylamine oxide (from herring) was found to be cumulative, and appeared to be of exogenous origin. On the other hand, the origin of trimethylamine oxide in fresh water fish from a local lake appeared to be of endogenous origin.

A study was made of the reduction of trimethylamine oxide to trimethylamine in marine fish held at different storage temperatures. Samples of fish used included haddock in the round, fresh and frozen haddock fillets, and cod muscle press juice. In the haddock samples, only negligible amounts of trimethylamine resulted from sources other than trimethylamine oxide. Data obtained from the other samples indicated that the determination of trimethylamine was not always a reliable test for freshness. Thus the value and usefulness of the test is limited.

Tests involving the reducing of trimethylamine oxide *in vitro* by different bacteria indicated that the oxidation-reduction potential has a bearing on the reduction of the oxide to trimethylamine. Bacteria which were able to reduce the oxide created a reducing atmosphere in the medium. Aeration of the medium inhibited the reduction.

Attempts to obtain a bacterial-cell-free preparation of triamineoxidase, the enzyme responsible for the reduction of trimethylamine oxide to trimethylamine, were unsuccessful.

**Home Preservation of Herbs.** (W. B. Esselen, Jr., and S. Yang.) Work has been continued on the home preservation of such herbs as basil, marjoram, summer savory, mint, sage, burnet, thyme, and dill. Drying in an attic or in the shade or in a cabinet with forced-air circulation gave the best retention of essential oils in herbs. With a number of different herbs studied, mid-day was the best time to harvest them as their essential oil content was higher then than in the morning or late afternoon. Fresh herbs were quite satisfactory when frozen without being blanched, although they tended to darken when thawed. Blanching prior to freezing is not recommended because it causes a loss of most of the essential oil. Mint syrup and dill, dill and garlic, basil, and burnet vinegars have been prepared. Burnet vinegar has a tendency to turn black upon exposure to the air, apparently because of the iron content of the burnet. Such discoloration can be prevented by the addition of an antioxidant such as ascorbic acid (vitamin C) or a chelating agent such as "Sequesterene" (the disodium salt of ethylenediaminetetracetic acid).

**Factors Influencing the Mold Content of Cranberries.** (W. B. Esselen, Jr., and C. R. Fellers.) Ninety samples of fresh cranberries from different bogs and commercial canners were collected during October, November, and December 1949. They were made into sauce and their mold count determined. The mold counts of sauces made from sound fruit ranged from 0 to 12 and were in general agreement with similar mold count tests made during the 1947 and 1948 seasons.

**Utilization of Massachusetts Fruits for Home Wine Making.** (W. B. Esselen, Jr., E. E. Anderson, I. S. Fagerson.) During 1949 experimental lots of wine were made from sweet cherries, currants, elderberry blossoms, raspberries (both red and black-cap), blackberries, blueberries, peaches, and pears. Acceptable wines were made from all the fruits with the exception of blueberries. The addition of 4 grams of ammonium phosphate, ammonium nitrate, or urea per gallon of must as a yeast nutrient improved the rate of fermentation and quality of the fruit wines.

**Processing Atlantic Tuna Fish.** (C. R. Fellers.) The "little tuna" (*Euthynnus alleteratus*), which is abundant off the New England Coast, was frozen and canned. This fish weighs about 9 to 15 pounds and is a light-meat tuna of very good quality. Methods of fishing have not been perfected as yet. This fish makes a good quality canned product. As with the Pacific tunas, the "little tuna" must be first steamed to eliminate the strong-flavored body oil before packing with bland vegetable oil.

**Pre-Peeled Potatoes.** (E. E. Anderson, K. C. Li, and W. B. Esselen, Jr.) Preliminary work has been done on methods of preventing discoloration of peeled white potatoes. The preparation of such potatoes for distribution to hotels and restaurants is becoming an increasingly important enterprise in this area. When peeled potatoes are dipped in a solution containing 3000 p.p.m. of sulfur dioxide they may be kept for 10 to 15 days under refrigeration (35° to 40°F.). The thiamine content of such treated potatoes was well retained.

**Factors Influencing the Composition and Characteristics of Cranberries.** (W. B. Esselen, Jr., E. E. Anderson, and C. Flynn.) (In cooperation with the Massachusetts Cranberry Experiment Station and the National Cranberry Association, East Wareham, Massachusetts.) Ten crosses of cranberry varieties grown on



two different bogs in New Jersey were analyzed for color, acidity, pectin, ascorbic acid, flavor, and jellying properties. The bog on which the cranberries were grown had a significant effect on the properties and characteristics of the fruit, and also influenced the yield and quality of cranberry sauce made from the fruit. While these observations are of a preliminary nature, they point to the desirability of making a similar and more extensive study on Massachusetts cranberry bogs. Such an investigation has been scheduled for this coming season.

**Investigations on Cranberry Juice.** (E. E. Anderson, W. B. Esselen, Jr., F. Langevin, and I. S. Fageresen.) Cranberry juice was prepared from frozen cranberries using both hot and cold extraction methods, with and without pectinase treatments. The resultant juice was packed in glass and tin containers, stored under varying conditions of light and temperature, and analyzed periodically for color and flavor changes. Ascorbic acid and sodium pyrophosphate were of little or no value in preventing color deterioration in the stored product. Attempts to produce darker colored juices by re-extraction of the residual cranberry pulp, vacuum concentration of the extracts, and finally adding the concentrate back to the original juice were not judged to be commercially feasible or practical.

**Influence of Pyrophosphates in the Manufacture of Cranberry Sauce.** (E. E. Anderson and W. B. Esselen, Jr.) Recently the claim has been made that the use of "molecularly dehydrated phosphates," such as crystalline pyrophosphates, acid pyrophosphates, tripolyphosphates and metaphosphates, in the manufacture of red fruit products resulted in improved retention of the red color, inhibition of the darkening of these products during storage, as well as increased yields and gel strengths. In an attempt to substantiate the above findings with respect to the manufacture of cranberry sauce, samples were prepared with sodium pyrophosphate. Concentrations of 0.44, 0.88 and 1.73 percent sodium pyrophosphate were selected inasmuch as 0.8 percent was originally recommended for best results. Examination of the samples after a six-month storage period revealed a marked discoloration in all samples containing sodium pyrophosphate. The sauce at the headspace was colored a very light purple to a depth of one-eighth to one-quarter inches. The flavor in the sauce containing 0.44 percent pyrophosphate, while not objectionable, was somewhat blander than that of the controls. However, a decided off-flavor appeared in those samples containing 0.88 and 1.73 percent pyrophosphate. Although the gel strength of the samples with 0.44 and 0.88 percent pyrophosphate approximated that of the controls, the use of 1.73 percent pyrophosphate resulted in little or no gel formation.

**Effect of Manufacturing Processes on the Vitamin C Content of Cranberry Sauce and Cocktail.** (J. J. Licciardello, W. B. Esselen, Jr., and C. R. Fellers.) Fresh cranberries have been found to contain a significant amount of ascorbic acid; however, cranberry products are practically devoid of this vitamin. An investigation showed that, when the fresh berries were converted into sauce or cocktail, there was a progressive decrease in the vitamin C content incurred by each major operational step. It was further demonstrated that the destruction of the ascorbic acid was due to oxidation. In the manufacture of the sauce the oxidation was accelerated by the high cooking temperature and metal catalysts; whereas, in the production of the cocktail, the oxidation was promoted by the presence of oxidizing enzymes and metal catalysts.

**Moisture Equilibrium Studies.** (A. S. Levine, I. S. Fageresen, E. A. Nebesky, J. Cage.) This investigation has been continued and sorption and desorption isotherms for several foodstuffs have been determined. This type of data is

generally not easily available and is valuable in determining packaging requirements and storage life of the food materials in question. A simplified procedure which was developed for determining these sorption and desorption isotherms gave results in good agreement with standard methods.

**Studies on the Mechanism of Heat Transfer in Commercial Glass Containers during Thermal Processing.** (I. S. Fagerson and W. B. Esselen, Jr.) Some of the factors which influence the heating rates in commercial glass containers during thermal processing have been investigated.

*Time-Temperature Distribution Patterns in Commercial Jars.*—Data have been obtained for commercial 303 and 2½ size jars at initial temperatures of 140° and 180°F. processed with steam under water at 240°F. One percent bentonite suspensions were used for convection type heating and 5 percent bentonite for conduction type heating.

In the 5 percent suspensions the patterns showed an initial lag period as indicated by a small temperature differential between points near the center of the container as compared to the differential between the wall and the outermost thermocouple. Following the lag period, the temperature rose more or less uniformly from the center to the wall of the container. It was noted that, though the metal lid of the container has a greater thermal conductivity than the glass wall, this did not appear to affect significantly the characteristic patterns of simple conduction heating across the central horizontal plane which is similar in form to patterns obtained for 5 percent bentonite suspensions in cans.

In the 1 percent suspensions the patterns obtained appeared to confirm Jackson and Olson's hypothesis on the mechanism of heat transfer in cans. Further confirmation was obtained by studying the direction and distribution of convection currents on introducing methylene blue into containers filled with water and recording the resulting currents by means of motion pictures as the jars were heated in a constant-temperature bath.

*Process Value Distribution.*—Process value or  $F_0$  value distribution have been obtained for both sizes of containers for both convection and conduction type heating using the bentonite suspensions previously mentioned.

In conduction type heating  $F_0$  values were at a minimum at the approximate geometric center of the container. This is in agreement with theory and confirms the generally accepted locale of the cold point. When this region has received the desired process value all other points are overprocessed.

In the case of convection heating, it was noted that zones intermediate between the jar wall and the vertical axis of the jar and in the same horizontal plane as the usually accepted "cold zone" showed  $F_0$  values lower than points on the vertical axis. This observation is of significance in that cold zone determinations are generally based on the assumption that the critical zone is centered on the vertical axis of the container, heat penetration tests usually being carried out to ascertain the height on the axis where the process value is at a minimum. This phase of the work is being continued, present studies being carried out to determine the magnitude of this effect in containers of actual foods which exhibit convection heating.

*Radiation as a Mechanism Heat Loss During Air Cooling of Glass Containers.*—Radiative heat loss in air from 303 size glass containers was compared with that of a No. 2 plain tin as well as fruit and "C" enameled cans. It was found that comparatively large amounts of radiation occur from the plain glass containers when filled with 1 percent bentonite suspensions and cooled in air. This radiative heat loss is greater from plain glass than from tin containers.

*Factors for Converting Heating Rates from One Jar Size to Another.*—In calculating a thermal process for foods according to mathematical methods it is necessary to know the temperature of the food in the container during the sterilization period. Usually time-temperature relations are determined experimentally. Often these tests are made with only one size of container and at a later date it may be desirable to know what these relations would be if the same product were packed in a container of different size. It is therefore desirable to have some means of calculating heat penetration data for one container size to the equivalent for another size.

It was found that available formulas for converting heating rate data in cans of food heating by conduction as represented by 5 percent bentonite suspensions are applicable to glass containers of dimensions similar to the 2½ and 303 size containers.

Relationships for converting heating rate data in cans of food heating by convection are not applicable when applied to glass containers. Accordingly, two empirical relationships for conversion of heating rate data in glass were developed which give good agreement with experimental values as determined in 1 percent bentonite suspensions.

*Mechanisms of "Broken-Curve Heating".*—Attempts to obtain broken heating curves in 303 size jars utilizing 3¼ percent bentonite suspensions were not successful. It was found that such curves were obtained with 2 percent suspensions. The use of materials other than bentonite for the production of broken curves was investigated, among these the 100 and 500 cp grades of Dow Methocel, Du Pont Carboxymethylcellulose, Du Pont Ludox (a colloidal dispersion of hydrated silica), Du Pont polyvinyl alcohol, and Vulca 30 (an ether derivative of ungelatinized starch), none of which proved suitable.

A study on the role of retort come-up-time on the production of broken curves utilizing the 2 percent suspensions indicated that increasing the come-up-time had the general effect of shifting fh values from those representing convection to those representing conduction type heating. Under the conditions of the experiments, the maximum value of come-up-time which leads to the production of broken curves is approximately three minutes.

**The Effect of Ethylenediaminetetracetic Acid (Sequesterene) on the Copper and Iron Catalyzed Destruction of Ascorbic Acid.** (W. Averill and C. R. Fellers.) The protective effect of ethylenediaminetetracetic acid on the copper, iron, and copper plus iron catalyzed destruction of ascorbic acid was studied in phthalate buffers of pH 2.5 to 6.0. Ethylenediaminetetracetic acid was very efficient in its ability to inhibit the copper-catalyzed oxidation of ascorbic acid in this pH range.

The presence of ferrous ions did not greatly increase the rate of oxidation of ascorbic acid but did increase the amount of ethylenediaminetetracetic acid required to inhibit the copper-catalyzed oxidation of ascorbic acid.

**Date Investigations.** (C. R. Fellers, I. Rashid, and M. S. Rahman.) For the first time, analyses of date protein for the indispensable amino acids has been made. Enzymes are responsible for most of the physical and chemical changes which take place in dates during ripening. Canned dates, date paste, and other date products have been prepared using both Egyptian and California dates.

**Vitamin D Investigations.** (C. R. Fellers, L. R. Parkinson, and K. C. Li.) It has not been possible to use proposed chemical and spectrophotometric methods for the estimation of the vitamin D content of milk. Check rat assays on vitamin



D milks produced in the State show that the 400 unit per quart guarantee is being complied with.

**Non-Toxicity of Ethylenediaminetetracetic Acid (Sequesterene).** (C. R. Fellers, L. R. Parkinson, and S. S. Yang.) This complexing (sequestering) agent has been suggested for the neutralization of heavy metals in foods, beverages, brines, syrups, and sea foods. Hence, it is of great importance to ascertain the toxicity of the compound.

Feeding experiments with albino rats have been under way for 20 months. Daily feeding levels of 0.25, 0.5, and 1.0 gram have resulted in no observable change in the gross appearance of the animals or their organs. Neither has there been any appetite or weight loss. It is concluded that the disodium salt of ethylenediaminetetracetic acid is non-toxic and is suitable for use in foods. The quantity required for neutralizing (chelating) copper is approximately 5 p.p.m. for each p.p.m. of the metal.

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#### DEPARTMENT OF FORESTRY AND WILDLIFE MANAGEMENT

R. P. Holdsworth and R. E. Trippensee in Charge

**The Effects of Seedbed Treatment on the Natural Establishment of Eastern White Pine.** (Arnold D. Rhodes.) In August 1947, sixteen one-fortieth acre plots were established under an even-aged stand of eastern white pine approximately fifty years old, which, because of poor form and quality, was about to be clear-cut. Four conditions of seedbed were created as follows, each replicated three times: removal of the forest floor by burning, removal by raking, scarification of the floor by turning a tractor on one tread, and retention of the floor undisturbed (control).

A heavy crop borne that fall deposited seed at the approximate rate of 400,000 seeds per acre as determined by eight seed traps. The actual number of seeds which fell upon any one plot is not known. During the ensuing winter the pine was harvested, and all woody vegetation except the smallest shrubs was cut back to the ground. All cut material and logging slash were removed from the plots, leaving the cutting area without overhead shelter and protection against solar radiation. Germination of seed and survival of seedlings were recorded at weekly intervals during the spring and early summer of 1948, and at longer intervals later. Results after two years of observations are as follows:

1. Germination was adequate by any form of treatment, including undisturbed forest floor, and does not appear to pose a problem. Conditions influencing survival are the critical factors.

2. Initial survival was favored by the development of herbaceous growth, which protected seedlings against high temperatures. Such development was most rapid on raked plots, least on control plots, and intermediate on the others.

3. Second-year survival was reduced materially by the competitive effects of both herbaceous and woody vegetation, which became established in abundance on all plots except the control. In short, survival was poor on undisturbed forest floor for want of shade, and poor on disturbed forest floor because of competition.

4. After two years the percentage of survival for the four treatments—control, burning, scarification, and raking, respectively—was 3, 21, 21, and 34, the number of high-vigor seedlings per acre was 0, 800, 1,400 and 2,400, and after one year the number of woody stems other than pine per acre was 3,000, 11,800, 14,600, and 79,700.

*Significance:* Clear-cutting in large units, with or without disturbance of the seedbed, discourages the ultimate establishment of white pine even when the

seed supply is abundant. The most satisfactory system of regeneration would appear to be a partial cutting such as shelterwood, group selection, or clear-cutting in narrow strips or small blocks, which leaves larger trees to provide shade and shelter, at the same time leaving the forest floor intact where possible as a check against establishment of competition. Experimental studies are being continued to test this hypothesis.

**Factors Affecting Damage to Communication Cables by Squirrels, and the Possibility of Developing Means of Preventing Such Damage.** (Raymond Sherman and R. E. Trippensee.) This is a continuation of the study of gray squirrel damage to lead and plastic covered telephone cables, carried out in previous years by Paul A. White, Wesley Jones, and R. E. Trippensee. The number of squirrel cages was increased to 18 and the number of squirrels tested varied from 16 to 24. Squirrels were tested singly and in pairs. Cables of various sizes and with both lead and polyethylene coatings were used. Tests were run with a variety of diets, all, however, included the basic fox chow feed and water. Two squirrels were born in captivity to a female placed in the cage without a mate on January 8, 1950. No accurate record could be obtained as to when the young were born.

Records were kept of the degree of damage to both lead cable and alpth. These were tried untreated and treated with several repellents. Those used were as follows:

Experiment 2. Burbank's coon and weasel scent, made for Sears, Roebuck & Company, and Goodrite Z.A.C., zinc dithiocarbonate amine. These repellents did little to discourage chewing, in fact, they seemed to attract squirrels, as the damage was heaviest where they were applied. This might, however, be due to the fact that it was given to squirrels that do the most chewing.

Experiment 3. Four different repellents were used. Diamond tree paint produced good results, the damage was very slight. A rabbit repellent, 96A, proved very unsatisfactory, the damage was greater where it was applied than where it was left off. Rabbit repellent 252 was unsatisfactory, results were the same as on untreated cable. Goodrite's Z.A.C. proved more successful in this experiment, but from previous results in Experiment 2 it is not recommended as a squirrel repellent.

Experiment 6. A hose was tested to which was applied Ensign No. 369, both clear and brown. The treated hose was damaged far less than the untreated hose, but damage was not completely prevented.

As to over-all results: The cable damage in this last experiment, No. 6, was somewhat under average, but damage to cages and boxes was far above average. When cage and cable damage was coupled together, the average showed an increase in the total amount of damage. Also this experiment showed greater damage from female adults than from male adults, which had not previously been the case. Young of either sex seem to cause much damage also. The two young squirrels born at the wildlife laboratory this spring did 2.6 times more damage than the average for adult squirrels. There were, however, individual adults that did greater damage.

**Testing of Material Which May Retard Seed Damage by Rodents.** (Wesley R. Jones and R. E. Trippensee.) Several small rodents were used for this test: domestic white mouse (*Mus musculus*), common house mouse (*Mus musculus*), and white-footed mouse (*Peromyscus leucopus*). Dry repellent was dusted on kernels of corn or corn was immersed in a solution of the repellent. In this way the repellent adhered to the surface of the corn. Fox checkers and water were available in sufficient quantity. None of the nine materials tested seemed to

have any retarding effect on the several rodents. All ate the treated corn without any hesitation. No degree of difference could be detected between any of the repellents tested.

**Factors Influencing Use of Artificial Nest Boxes by Wood Ducks.** (James L. Chamberlain.) Before the nesting season of 1949, State Conservation Department personnel erected 62 artificial wood duck nesting boxes at Great Meadows Refuge in Concord, Massachusetts, as part of a state-wide effort to increase wood duck populations. To test the effectiveness of this technique, a detailed study was begun in the spring of 1949 by personnel from this Institution. The results of the first season's study may be summarized as follows:

Twenty-five broods comprising a total of 306 ducklings were produced in the 62 boxes on the refuge. While 73 percent of the boxes were utilized, 20 failed to produce broods. Circumstantial evidence indicated that many hens lay eggs in more than one box, thus accounting for the unproductive clutches.

The study was continued in 1950 by personnel of the State Division of Fisheries and Game.

Cooperators in this and the four following projects: U. S. Fish and Wildlife Service, Massachusetts Division of Fisheries and Game, the Wildlife Management Institute, and the University of Massachusetts.

**Ecology and Management of the Muskrat in Massachusetts.** (James L. Chamberlain.) This study was started in 1949 with the objective of determining the present status and economic value of the muskrat in Massachusetts and recommending the soundest management policy.

A detailed ecological study of this furbearer has been started at Great Meadows Refuge in Concord. Approximately 75 animals have been trapped, tagged, and released. Data on age and sex ratio, movements, reproduction, and condition have been recorded. In conjunction with this study a vegetative map has been made of the marsh area, and some marsh management experiments have been carried out.

In addition, a state-wide survey has been made to find the areas yielding the largest number of muskrats. Several hundred pelts have been examined and graded for primeness and sex and age ratios. Records have been kept by cooperators on the kind of habitat where these graded pelts were taken. Pelts become prime earlier in the year in western Massachusetts than on the east coast. In all areas, most of the muskrats are trapped early in the season before the coats are fully prime.

**Experimental Land Management Techniques to Increase the Population of Cottontail Rabbits.** (Francis H. Fay.) The main objective of this study is to work out techniques of managing submarginal abandoned farmlands so that a maximum number of cottontail rabbits can be produced. Work of clearing and planting has been begun on an experimental 90-acre plot in the town of Upton.

**Woodcock Studies.** (William G. Sheldon.) Original techniques have been developed for banding adult woodcock on their breeding grounds in Massachusetts. In the spring of 1950, 96 birds were captured, banded, and released. In addition, two annual censuses have been made of woodcock populations in the central part of the State. Other cooperators have been solicited to make this a state-wide study. As banded birds are returned and cooperators' annual reports analyzed, a more complete record will be made of the status of the bird in this State. Basic ecological facts will also be sought and thus contribute to wiser national management policies for this economically important migratory upland game bird.



**Factors Affecting the Population of Ruffed Grouse.** (C. F. Banasiak and William G. Sheldon.) In the spring of 1949 research was begun on ruffed grouse, with the main objective of learning whether gunning pressure or land changes are of greatest importance in affecting population changes. Detailed studies of two representative areas are being conducted, and over four hundred pertinent observations of these birds have been recorded. Census data are recorded regularly to keep abreast of the monthly and annual population shifts of this species.

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## DEPARTMENT OF HOME ECONOMICS NUTRITION

Anne Wertz in Charge

**The Nutritional Status of Pregnant Women.** (A. W. Wertz, M. E. Lojkin, P. Van Horn, G. C. Hagan, and C. E. Greenfield.) As reported previously (Mass. Agr. Exp. Sta. Bul. 449, p. 58, 1948) this project is part of the Northeast Regional Cooperation Project on Nutritional Status and is being done with the cooperation of Dr. Eugene M. Holden of Amherst. Fifty-five pregnant women have been studied to date. As the project will continue for at least another year, it is not yet feasible to evaluate the data accumulated thus far.

**A Study of the Methods for Obtaining Dietary Histories.** (G. C. Hagan, A. W. Wertz, P. Van Horn, and C. E. Greenfield.) Sufficient data have been collected on this study for statistical analysis and evaluation, which is now being made. The results and recommendations are not yet available.

**Relation of Ascorbic Acid in Umbilical Cord Blood, Maternal Blood, and Maternal Diet.** (A. W. Wertz, C. E. Greenfield, G. C. Hagan.) It has been possible to date to obtain the cord blood from 15 women at parturition and analyze it for ascorbic acid. The ascorbic acid in the cord blood ranged from 0.95 to 3.64 milligrams percent with an average of 1.92 milligrams percent. The ascorbic acid in the blood of these same women during the last month of pregnancy ranged from 0.37 to 2.72 milligrams percent with an average value of 1.13 milligrams percent. These results indicate that the average ascorbic acid value of the cord blood is approximately 70 percent higher than the average value for maternal blood. However, in the cases studied, no correlation was found between the amount of ascorbic acid in cord blood and maternal blood. Neither was any correlation found with the amount of ascorbic acid in the maternal diet which ranged from 22 to 123 milligrams per day with an average value of 75 milligrams. Additional data are being collected on this study.

**Relation between Nicotinic Acid in Umbilical Cord Blood and Maternal Diet.** (C. E. Greenfield, G. E. Hagan, and A. W. Wertz.) In the 21 subjects studied so far there appears to be no correlation between the amount of nicotinic acid ingested in the diet and the amount of nicotinic acid found in the umbilical cord blood. The nicotinic acid content of the diet ranged from 5.1 to 19.8 milligrams daily with an average of 12.5 milligrams. The cord blood values ranged from 10 to 104 micrograms per 100 milliliters with an average of 55 micrograms per 100 milliliters. This study is being continued.

**Nicotinic Acid Metabolism in Pregnant Women.** (M. E. Lojkin, A. W. Wertz, C. E. Greenfield, and G. C. Hagan.) In 100 percent of the women studied there was a higher urinary excretion of N-methylnicotinamide during pregnancy than in the non-pregnant state. This increase is most marked in the latter months of pregnancy. In about 75 percent of the cases studied there was a slight increase in the amount of nicotinic acid excreted during pregnancy. In many cases the

amount of nicotinic acid metabolites that are excreted in the urine exceeds the amount of nicotinic acid ingested in the diet.

**Nicotinic Acid Metabolism in the Pregnant Rat.** (M. E. Lojkin, C. E. Greenfield and A. W. Wertz.) To further the study of nicotinic acid metabolism during pregnancy, the albino rat was used as an experimental animal. The results showed that the urinary excretion of nicotinic acid and N-methylnicotinamide increased during the latter stages of pregnancy, in some cases being highest on the day of parturition. The excretion of N-methylnicotinamide did not drop to normal levels until several days after the birth of the young. The increase in the excretion of nicotinic acid metabolites during pregnancy does not appear to be correlated with the increase in weight of the animal or with the amount of nicotinic acid ingested.

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## DEPARTMENT OF HORTICULTURE

Clark L. Thayer in Charge

**Study of Herbaceous Perennial Material.** (C. J. Gilgut and Paul Bobula, Waltham.) The test garden of herbaceous perennial ornamental plants adaptable to our local climatic conditions was maintained in a presentable and attractive condition in spite of the extremely dry summer.

Forty-four plants were lost in the garden, either because they could not survive growing conditions or because they lacked garden value and were removed. In addition, out of ninety named chrysanthemums which are so-called hardy types only twelve lived over winter. It is increasingly apparent that the term "hardy" is a misnomer when applied to most garden chrysanthemums. Fifty-eight new plants were placed in the garden as replacements or as introductions newly available in the trade.

The test garden continues as a source of information on garden value, hardiness, cultural requirements, and flowering habits of plants for New England conditions that is available nowhere else, and continued public interest is indicated by the regular visits of large numbers of people who come to observe and study these plants.

The phlox collection was extended with new varieties for studies of trueness to name and garden value. It is evident that garden phlox are in a chaotic state regarding names, many being offered to the public under several names. This group of plants needs additional study.

The hemerocallis collection is now well established and receiving critical study for garden value.

Contrary to reports of some investigators, foliar nematode of hardy garden chrysanthemums was not controlled by parathion sprays, nor was chlordane or benzene hexachloride effective. The treatments will be repeated this season.

**Factors Influencing the Rapidity of Growth of Nursery Stock.** (C. J. Gilgut, Waltham.) Leaf bud cuttings of named varieties of rhododendron were taken in September, October, November, and December in an effort to obtain large enough percentages of rooting to make the practice commercially feasible. Rooting was better in sand-peat mixture than in sand alone when cuttings were treated with commercial hormone powders or with indolebutyric acid using 60 mg. per liter for 24 hours. Results, however, were disappointing since the number rooted, particularly of the more desirable named varieties, was small. The shortage of good named varieties of hybrid rhododendrons on the market makes it desirable to continue investigation of practical methods of propagation.

Fifteen hundred seedlings of a red variety of rhododendron have been lined out for the purpose of color selection and, specifically, to determine whether such selections will root more easily from leaf bud cuttings than named varieties now in commerce.

Rooted cuttings and seedlings of nursery stock lined out in the summer often suffer severe bark injury from early hard frosts and wood injury from cold, during the first winter. It is believed this is caused by heavy fertilizer applications and failure of plants to harden off sufficiently and mature early enough in the fall. Plots of *Thuja occidentalis*, *Taxus capitata*, *Rhododendron poukhanense*, *R. carolinianum*, *Azalea molle*, *A. kaempferi*, and *A. mucronulatum* were treated with 1 ton per acre of cow manure, castor pomace, Spurz-on (commercial hen manure), or 5-8-7, 1500 pounds per acre of superphosphate and muriate of potash. Before hard fall frosts one-half of each plot was killed up to determine the effect of this cultural treatment on prevention of injury.

There was no frost or winter injury on any of the plants, including those which received no treatment; therefore, applications of fertilizer as the cause of frost injury could not be determined. Effect on growth, however, was evident. Best for all varieties was castor pomace and next was Spurz-on. Manure was poor, and 5-8-7, muriate of potash, and superphosphate at the rates applied caused some injury, no doubt due to the extremely dry conditions which prevailed after application, although an effort was made to keep the plants watered.

**Control of Weeds in the Nursery by Chemical Sprays.** (C. G. Gilgut, Waltham). Sovasol No. 5 was applied to nursery plants, as in previous years, with a hand sprayer because of the need of careful control of spray to avoid injury to susceptible, valuable ornamental plants. Results of previous work were verified and confirmed. (See report for 1949.)

As a pre-emergence weed killer for gladiolus bulblets, Sovasol No. 5 was again found to be effective. It is better than 2, 4-D preparations which do not kill grasses.

The 2,4-D preparations, Esteron 245, Sherwilkil No. 2, Weedone 32, Weedar 64, Esteron 44, and Weednomore were less effective for control of ordinary weeds in the nursery than Sovasol No. 5 but were more effective for brush killing.

DuPont TCA 60 percent (trichloroacetate) was applied to witch grass during the extremely dry period in August. The following spring there was 95 and 90 percent reduction of spring growth of witch grass where 200 and 150 pounds per acre was applied, 80 percent with 100 pounds per acre, and less than 40 percent with 60 pounds per acre.

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## DEPARTMENT OF OLERICULTURE

### Grant B. Snyder in Charge

**Asparagus Investigations.** (Robert E. Young, Waltham.) In a breeding experiment to develop a higher yielding strain of asparagus, the past year's records continue to indicate the superiority of the selected lines over the commercial varieties. The average yield of the four top-producing strains was 100 pounds per plot as compared to 57 pounds for the two commercial varieties.

In the second full cutting season the yield did not increase as expected but showed a 4 percent reduction from the previous year. This is attributed to dry weather during the cutting season. The dry weather also caused 25 percent reduction in the number of summer stalks produced. The better-producing strains did not show as much reduction as the poor ones.



Individual plant yield records were made on four strains in order to isolate better parent material for future use. The average weight of spears from these plants was 0.96 pound per plant. The top ten plants in each strain produced more than 1.6 pounds per plant, and only 14 percent of the plants in these four strains produced less than  $\frac{1}{2}$  pound per plant, indicating uniformly good production from almost all plants. Since there is some variation in the yield of individual plants from year to year, records must be obtained for several seasons before the best parent material can be selected for release to growers.

**Vegetable Breeding for Improvement of Quality.** (Robert E. Young, Waltham) Progress has been made in the development of strains of Butternut squash, celery, and cabbage better adapted to local use. Work was along the lines previously indicated, but new developments are not conclusive enough to warrant detailed report at this time.

**Broccoli.**—In 1949 the fall crop of broccoli produced results that demonstrated the superiority of Waltham No. 11 and Waltham No. 29 strains over commercial varieties. In order to harvest all of the crop as it developed, it was necessary to cut the commercial varieties eight times while only four or five harvests were necessary for Waltham 11 and 29. The No. 11 produced approximately 10 percent more marketable crop than the commercial varieties. The No. 29 does not produce a greater yield but it will stand hot weather without opening up and blossoming.

Replicated trials in the spring of 1950 showed that Waltham No. 11 produced 16 percent more total yield and 25 percent greater yield of marketable shoots than did the average of the five most widely used commercial varieties. This strain is now being tried by many growers on a larger scale.

**New York Type Lettuce.**—An experiment was set up to determine possible cause of the development of a cone-shaped head in the variety Penn Lake lettuce. This trouble occurred in many fields in Bristol County in 1949, and in some instances 50 percent of the plants were affected. The trouble does not occur when the same seed is planted directly in the field.

The results of this experiment showed that, where the plants were planted deep, well over 50 percent of the heads were cone-shaped and all were very small. Where the plants were planted on a small ridge, all heads were round and very large. From one year's results, it appears that planting Penn Lake lettuce on a ridge will eliminate the cone-shaped head.

**Trellis Tomatoes.**—The use of an A-type trellis for the production of trellis tomatoes is becoming increasingly popular with the growers. It is a system of planting two rows 2 feet apart and training to a single trellis. The space between the trellised plants is 6 feet, which allows for the use of machinery for spraying. This method has greatly reduced the cost of production.

Trials were conducted to see what effect this new method has on production, and one year's results indicate a good increase in the percentage of No. 1 fruit. There was a slight reduction in the average size of fruit. The greatest difference observed in this experiment was in the reduction of total yield by the A-trellis method. Whether or not the reduction in the cost of production and the increase in No. 1 fruit are sufficient to offset the loss in yield can be determined only after several more trials of the system.

Breeding to improve our strain of trellis tomatoes by the incorporation of resistance to cracking has progressed to the third generation and some of these strains have shown only half the cracking of Trellis No. 22. Late maturity has been associated with the crack-resistant character, and these third generation

strains are slightly later than Trellis No. 22, but back crosses have been made to overcome this tendency.

Last year a report was made on the fruit set and yield of trellis tomatoes when the blossoms were sprayed with hormones. That was in a year when below-normal temperatures existed for two weeks after the plants were set in the field. In 1949, the experiment was repeated and the temperature was above normal, a condition which favors normal setting of fruit. The hormones produced an increase of 6 percent in set of the first cluster but a reduction of 8 percent in the set of the second cluster. The yield from these plots is in favor of the hormone treatment by 11 percent for the first two pickings and 4 percent for the third and fourth. There was no significant difference in the total yield. From two years' results, it would seem that the application of hormones to trellis tomatoes is a practice that can be recommended.

*Greenhouse Tomatoes.*—In an experiment to determine the value of hormone sprays in the greenhouse, the bottom or first cluster of the spring crop of tomatoes was sprayed three times. Those clusters that were not sprayed set 53 percent of the flowers while the hormones produced a set of 95 percent. The second cluster was not sprayed, to see whether the heavy set induced by the hormone affected the sets above. Where the plants had been treated for the first cluster, the second cluster set only 45 percent of the flowers, while 54 percent set on the check plants. In the third cluster the plots were reversed and again the hormone produced a set of 70 percent as compared to 40 percent for the no treatment.

The first three weeks of harvest showed that the plants sprayed with hormones produced twice as much fruit as the untreated. The quality of the fruit where it was set artificially was not as good but the increases in production were so outstanding that the treatment is suggested for growers when the weather is adverse and the blossoms fail to set naturally.

In trials in both the spring and fall, the greenhouse hybrid tomato (Waltham Forcing X Michigan State Forcing) produced more fruit than the Waltham Forcing. The percentage of No. 1 fruit was higher, also. In a few of many trials in growers' houses, the fruit has been too large. For those growers who have difficulty in getting sufficient size with the regular variety, the hybrid is recommended.

*Carrots.*—The carrot breeding work in which the objective is a better-colored Hutchinson carrot has progressed to where the two best selections are being multiplied for trial on growers' farms. The best of these, a cross between Hutchinson and Emperor, produced a much larger percentage of marketable roots than did the Hutchinson.

In a carrot spacing experiment to determine the most advantageous spacing for the production of the small-sized roots now demanded in the market, the largest production of No. 1 roots was obtained with the closer spaced rows. When only three rows were planted in a 57-inch bed, as many as 15 percent of the crop were too large, which compares with 0.9 percent for six rows to the bed. While this experiment must be repeated many times for conclusive results, the data indicate that more bunches of marketable carrots can be harvested per acre if the rows are not over 12 to 14 inches apart, instead of the 18-inch spacing used by some.

**Weed Control in Vegetable Crops.** (William H. Lachman.) Tests were conducted where twenty-three different treatments were applied to a field of North Star sweet corn for the control of weeds. All of the treatments were pre-emergence applications of the chemicals, i.e., applied after planting but before the emergence of the crop.

All weeds except smartweed were controlled for a period of four weeks by 2,4-D applied at 1.5, 2.0, or 3.0 pounds per acre. It was evident that smartweed is very resistant to 2,4-D in pre-emergence applications. These treatments caused the malformation known as onion-leaf in the corn, with increasing severity as the rate of 2,4-D was increased. While the yield of corn was not significantly lower on the 1.5 pounds per acre plots than on the control plots, the 2.0 and 3.0 pounds per acre treatments did reduce the yield significantly. Applications of 2,4-D delayed until the crop was barely emerging from the soil were superior to treatments made just after planting time.

Sodium pentachlorophenate, a wood preservative, applied as a spray at the rate of 10, 20, or 30 pounds per acre proved to be among the best of the treatments, with 20 pounds of this chemical perhaps giving the most satisfactory and economical control. Excellent control of all annual weeds for a period of four to five weeks resulted from this treatment.

Applications of 1.5, 2.0, 3.0, 6.0, or 9.0 pounds of dinitro-o-sec-butyl-phenol (DNOSBP) and duplicate treatments with the ammonium salt of this chemical were also made. From 3.0 to 6.0 pounds were necessary to control weeds adequately, and 9.0 pounds proved to be deleterious to the corn. It appeared that DNOSBP and its ammonium salt were comparable, on a pound for pound basis.

Sulfasan at 5.0 or 10.0 pounds per acre gave no perceptible weed control. Later tests indicated that at least 50.0 pounds of this material per acre were required to kill weeds. Cyanamid applied at the rate of 400 pounds per acre immediately after planting gave very poor control. Later tests indicated that it was necessary to delay the application for seven to eight days after planting in order to obtain good weed control from Cyanamid. This treatment was effective in promoting nitrogen stimulation of the corn.

A mixture of 1.0 pound of 2,4-D and 10.0 pounds of sodium pentachlorophenate was not outstanding in its control of weeds, and about 3.5 percent of the corn plants were malformed.

It was readily apparent that none of the tests were effective to the extent that weeds would remain controlled all through the season. Even where good control of weeds resulted, it was necessary to cultivate four or five weeks after treatment with the chemicals. Nutgrass, a member of the sedges, was not affected to any marked extent by any of the treatments mentioned.

A number of materials applied to snap beans in pre-emergence applications again showed the value of a 20.0 pound per acre application of sodium pentachlorophenate. This treatment caused a definite chlorosis to appear on the first pair of bean leaves, but this condition was not present at any later stage of growth.

**Breeding Sweet Corn, Peppers, and Field Tomatoes for Massachusetts.** (W. H. Lachman.)

*Sweet Corn.*—Gold Mine (Mass. 2410-191 x C3) has been planted in widely scattered tests and in some cases has produced edible corn in 56 days from planting. This hybrid has repeatedly demonstrated its cold resistance and extra earliness. It is interesting to note its extreme cold resistance when made with the Mass. 2410-191 line as the female parent as opposed to the use of C3 as the female parent. Work is being continued to improve the stiffness of stalk, ear appearance, and quality. C12 and C2A were also used in making three-way and double crosses.

Golden Jewel has been judged to be almost as good in quality as Golden Cross Bantam, and it seems to retain this quality when frozen. Wide-scale testing this year definitely places its season of maturity between Marcross and Carmel-cross.



The attempt to develop an early Golden Cross Bantam type of plant and ear has been carried on to the extent that a large number of early seed parents are now available for testing, but desirable early pollen parents are still in the developmental stage.

The final crossing was accomplished to make a sixteen inbred hybrid. This material is now ready for self-pollinating in order to obtain new combinations of germ plasm for further breeding work.

An  $F_2$  population from Fort Kent Flint x Early Mass. 32 proved to segregate plants that were exceptionally early. In fact, some plants were three or four days earlier than C3, our earliest sweet corn inbred.

*Peppers.*—The performance of the pepper selections was a distinct disappointment this year. A period of extremely hot, dry weather was no doubt responsible for this condition. Growth of the plants was particularly lush but very few fruits set. In fact, only ten plants were selected for saving seed from the year's tests.

*Tomatoes.*—In further testing of  $F_1$  hybrids, the Red Cloud by Pennheart cross produced a very heavy yield of good quality fruit. The trials once again brought out the fact that there is a tendency for the fruit of  $F_1$  hybrids to be smaller than that of either of the parents. In several hybrids, however, where selection 32-1-2-2 was used as one of the parents, the individual fruit size held up very well.

Several tests using genetic male-sterile lines interplanted among normal tomatoes indicated that bumblebees cross-pollinated tomatoes to a greater extent in some locations than in others. None of the male-sterile lines produced as much seed when handled in this manner as normal plants. Whether this method can be used to produce  $F_1$  seed on a commercial basis is still an open question.

**The Culture and Nutrition of Vegetables.** (William H. Lachman.) Ten plantings of four varieties of hybrid sweet corn were made at approximately ten-day intervals to determine the relation of heat units to maturity in corn. It was found that 50°F. was the most reliable base temperature to use in order to determine the heat units accumulated from planting to maturity. During the season the number of days required for maturity varied from 55 to 94 for Spancross, 56 to 98 for North Star, 75 to 102 for Carmelcross and 81 to 111 for Golden Cross Bantam. There was a very close relationship between the degree of maturity and accumulated heat units for this crop.

The use of one of the synthetic growth substances, p-chlorophenoxyacetic acid at 30 parts per million definitely stimulated fruit set in Firesteel and Stokesdale tomatoes grown out of doors. In the extra early planting of potted Firesteel tomato plants, however, practically every fruit in the first three pickings developed blossom end rot. This material also set fruit on emasculated blossoms of Red Cloud, Pritchard and Waltham Forcing as well as on functional-sterile John Baer blossoms and on genetic male-sterile blossoms of Earliana.

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## DEPARTMENT OF POMOLOGY

A. P. French in Charge

**Storage Investigations.**—F. W. Southwick and E. Cox.) For use during the 1949-50 storage season homemade activated-carbon, air-purification units were built for two commercial apple storages. These units contained horizontal trays approximately 1 inch deep on which an even bed of coconut shell carbon was placed. Carbon was used at the rate of approximately 6 pounds per 1,000 bushels

of fruit. Each unit contained auxiliary fans to provide a positive air flow through the carbon, and the cleansed air was fed into the main blower-type cooling system. At the experiment station comparisons were made of apples held in rooms with manufactured cannisters of activated carbon and activated carbon brominated at 1 and 3 percent levels. In all rooms containing carbon (and comparable control rooms) composite samples of the varieties McIntosh, R. I. Greening, and Cortland were placed. From 12 to 26 days of storage life was added to all varieties wherever carbon was employed. The amount of scald on McIntosh and R. I. Greenings was reduced wherever carbon was used, although in some instances commercial control was not obtained. On these varieties carbon was generally superior to shredded oiled paper for scald control. On Cortland, however, carbon was a failure for scald control. Oiled paper failed to control it, also, but was superior to carbon. It appears that homemade units properly constructed may be as suitable as manufactured air-purifiers. Brominated carbon was not significantly better than unbrominated in its ability to increase the storage life of apples or to reduce susceptibility to scald.

Respiration studies were continued on tomatoes and apples. Measurements have been made to determine the influence of the hormone parachlorophenoxyacetic acid, which is used for increasing the fruit set of tomatoes, on the rate of respiration and ripening of the fruits. Similarly the influence of naphthaleneacetic acid type materials on apples, which have been treated shortly after calyx for thinning purposes, has been studied. Results are insufficient to allow any conclusions at this time.

**Influence of Chemical Treatments on Flowering and Fruiting of Fruit Trees.--**(F. W. Southwick and W. D. Weeks.) In the spring of 1949 emphasis was placed upon the use of naphthaleneacetic acid type materials (NAA) for thinning apples after calyx.

During the months from May through August, inclusive, the mean temperature averaged several degrees above the normal. Apples bloomed in early May about 2 weeks earlier than usual. Also, the months of June, July, and August were characterized by extreme drought. Under these conditions NAA materials applied about 2 weeks after calyx caused much more foliage damage than similar treatments applied in 1948. Several treatments distinctly overthinned.

However, promising results were obtained on Early McIntosh, Wealthy, Golden Delicious, and Baldwin by the use of from 20 to 30 p.p.m. of NAA applied approximately 2 weeks after calyx. Similar concentrations on Gravenstein and Red Astrachan failed to reduce the set. Duchess suffered so much foliage injury that the apples failed to develop as good size as those on similar trees hand-thinned several weeks later. Generally, chemically-thinned trees have a smaller total yield than unthinned trees but produce a greater volume of apples  $2\frac{1}{2}$  inches and up in diameter. It was found, also, that a commercial formulation of NAA containing a wetting agent caused more foliage damage and thinned to a greater degree than a similar material with no wetting agent. Indications are that naphthaleneacetic acid is as effective as equal concentrations of sodium naphthaleneacetate for thinning.

In the spring of 1950 records obtained from chemically-thinned trees showed that several biennial varieties bloomed sufficiently for a commercial crop in what would normally have been an "off" year. For instance, on some vigorous Baldwin and Early McIntosh trees which were somewhat overthinned in 1949 with NAA sprays applied about 2 weeks after calyx, about 25 percent of the growing points blossomed in 1950. These two varieties are extremely biennial, and it cannot be assumed that such results can be obtained frequently. Golden Delicious

and Wealthy, which are easier to make annual in production by early chemical thinning, have borne successive crops following NAA sprays applied about 2 weeks after calyx.

**The Influence of Various Clonal Rootstocks on Apple Varieties.** (W. D. Weeks and F. W. Southwick.) Because of light bloom and spring frosts, yields were too small in the main stock and scion orchard to make comparisons for most varieties. However, the crop of Rhode Island Greening was of sufficient size so that the effect of stock on yield could be measured. Trees on Malling XVI were more productive than those on Malling I and V. This difference in yield may be due in part to differences in tree size, as Malling XVI produces a larger tree than I and V.

Trunk circumferences taken from a 12-year-old block of McIntosh in a cooperative orchard indicate that trees on seedling roots are larger than trees on Malling XV, X, and XIII. The average trunk circumferences for McIntosh on seedling roots was 640 mm. Average trunk circumferences for trees on Malling XV, X, and XIII were 560, 533, and 489 mm.

An interesting observation was made in a cooperative orchard at Sterling on the effect of stocks on susceptibility to winter injury. Trunk injury to Baldwin trees on Malling IV was practically complete in that the bark had separated from the wood around the entire circumference of the tree trunk. Alternate Baldwin trees in the same row on Malling V showed no evidence of any injury whatever. Similar injury was observed with Red Spy and McIntosh on Malling IV but to a lesser degree. While Malling IV has been discarded because it makes a weak graft union, its susceptibility to winter injury gives another reason why it should be discarded as a rootstock for apples.

**Study of Bud Sports of the McIntosh Apple.** (W. D. Weeks and F. W. Southwick.) The amount and type of red color was determined for each of the seven strains involved in the test. Rogers continued to have the largest percentage of highly colored fruit. It also continued to be the only strain which did not have some striped fruit. The relative rank of the other strains was the same as the previous year. Preharvest drop records were obtained for each of the seven strains, but there were no significant differences among strains.

From the performance of the past two seasons Rogers appears to be a superior strain with respect to amount and type of red color.

**The Nutrition of Apple Trees.** (In cooperation with Chemistry and Agronomy.) (W. D. Weeks, F. W. Southwick, Mack Drake, Dale Sieling.) Because of the large reserve of nutrients carried over by the trees from the 1948 season, differences due to 1949 treatments were not significant. Measurements of fruit set, size, color, and yield were taken from the different plot treatments. Leaf samples were taken and analyzed for nitrogen, potassium, phosphorus, calcium, and magnesium. A comparison of the nitrogen content of 1948 leaves with that of 1949 leaves showed a slight decrease in nitrogen content as the rate of hay mulch was increased. Where 2 pounds of nitrogen were applied per tree there was a slight increase in leaf nitrogen.

Although no measurements are available for the 1950 season, observations of the trees receiving mulch indicate that they have a lower leaf nitrogen content as evidenced by their pale green foliage.

**The Nature of Winter Hardiness in the Raspberry.** (J. S. Bailey and F. W. Southwick.) At about monthly intervals through the winter determinations were made of the respiration rate of the canes of two red raspberry varieties:



Washington, a relatively tender variety; and Chief, a hardy variety. At the same time canes were placed in the greenhouse in water to check on the ending of the rest period and winter injury, if any. There appeared to be a slight decrease in the initial respiratory rate and a slight change in the slope of the respiratory curve at the time the rest period ended early in January.

Of the canes brought in March 20, those of Washington looked dry, as if they had been injured. Forcing in the greenhouse showed that the tip half of most of the Washington canes was dead. The Chief canes showed little or no injury. The respiration rate of the injured Washington canes was lower than that of the uninjured Chief canes.

**Blueberry Culture.** (J. S. Bailey.) In cooperation with Dr. F. R. Shaw of the Entomology Department, a study of the effects of DDT on bees was continued in the spring of 1949. A large colony of bees was placed in the Station blueberry field which was dusted twice with DDT. Applications were thorough and no attempt was made to avoid dusting bees or hive. Careful observation immediately after dusting revealed no evidence that DDT acts as a repellent as some have thought. In half an hour both honey and bumble bees were working blossoms. The weight of the hive decreased slightly for two days and then came back to the previous weight, indicating only slight and temporary injury to the colony. A report of this investigation appeared in the 1949 volume of *Gleanings in Bee Culture*.

In 1950, two colonies were exposed to (1) a 5 percent methoxychlor dust and (2) to a spray containing 3 pounds wettable methoxychlor in 100 gallons of water. A slight decrease in colony weight followed the application of the dust. However, at the end of the experiment the colonies had gained 3.25 and 6 pounds in weight. The results of these experiments will appear in the 1950 *American Bee Journal*.

Observations were continued on the new blueberry selections from the U. S. Department of Agriculture. A late frost gave opportunity to learn something of their frost resistance. This is reported in the variety project. Publication: *Frost Injury to Blueberries* by John S. Bailey: *Fruit Varieties and Horticultural Digest* 4(4):98. 1949.

Further checking on the blueberry stunt disease revealed only three or four new cases in the Cape Cod area. One nursery is reported to be importing stock from New Jersey where the stunt disease is very serious. Such a situation needs careful watching.

Publications: *Blueberry Varieties for Massachusetts*. John S. Bailey. *Fruit Varieties and Horticultural Digest* 4(4):91-93. 1949. *It's Time You Had Blueberries In Your Garden*. John S. Bailey. *Popular Gardening* 1(1):36-37, 63-65. 1950.

**Nutrition of the High-Bush Blueberry, Especially in Relation to Soil Reaction.** (J. S. Bailey and Mack Drake.) Again in 1949 some plants in the Station planting showed a type of chlorosis thought to be due to a lack of iron. An attempt was made to supply iron by dipping the ends of shoots in a 10 percent ferrous ammonium sulfate solution. The solution entered the leaves as shown by injury, even to leaves of adjacent shoots, but no greening resulted. Pad and thread injections of ferrous sulfate were tried also, but no greening resulted. These trials were made in early August which may be too late for greening.

In the late summer of 1949 a blueberry planting in Middleboro, Mass., showed signs of severe magnesium deficiency. A series of plots was laid out in triplicate. The treatments are check,  $MgSO_4$ , 150, 300, 600, and 900 pounds per acre, and dolomitic limestone at the rate of 500, 1,000, 2,000, and 3,000 pounds per acre.

Before the treatments were applied leaf samples were obtained from each plot. Chemical analysis showed the Mg content of the leaves to be extremely low. The highest value was 0.078 percent and the lowest 0.030 percent.

**Improvement of the Wild Low-Bush Blueberry.** (J. S. Bailey, W. D. Weeks, C. E. Cross, and F. R. Shaw.)

*Insect Pests.*—Through the cooperation of the Entomology Department, a graduate student, Thomas Loeber, was assigned to work on the insect problems of the low-bush blueberry. A report of his work follows:

1. Investigations of the seasonal history of the blueberry flea beetle.—In 1949, the hatching of eggs must have occurred about April 20 since young larvae were found in the field on April 25. The larvae fed for 12-14 days, spent 7 days as prepupae and 11.5 days as pupae. The first adult appeared on May 21. The seasonal history as observed in 1949 was approximately 3 weeks earlier than in 1948.

2. Control of the blueberry flea beetle.—Parathion, DDT, and lead arsenate were tested for control of this pest. Parathion proved effective both as a dust and spray against the feeding stages of the insect. DDT dust was inferior to an 85-15 lead arsenate-sulfur dust against late larval instars.

Publication: The Blueberry Flea Beetle. F. W. Shaw, J. S. Bailey and E. H. Wheeler. To appear in the Jour. of Econ. Ent.

3. Survey of insects of low-bush blueberry.—Some 35 species of insects were found injuring the low-bush blueberry. The blueberry flea beetle and blueberry maggot were most abundant. Several species of Lepidoptera, mainly Geometridae, were recorded. The following were most abundant: *Abbotana clemataria*, S. & A., *Glena cognataria* Hbn., and *Itame inceptaria*, Walker.

A large green stink bug, *Chlorochroa uhleri* Stal., was common and when confined in a box of blueberries contaminated the entire box.

*Clastoptera pro'eus* Fitch, the cranberry spittle bug, was present in moderate numbers from midsummer until fall.

Two blossom weevils, *Anthonomus musculus* Say and *A. rubidus* Lec., were fairly abundant. A small click beetle, *Cardiophorus convexulus* Lec., was present in large numbers throughout the season.

Further studies of the development and control of the blueberry flea beetle are in progress under the supervision of John Weidhaas. Life history studies indicate that, as in Maine, the insect passes the winter as an egg. Thorough burning eliminates the eggs and it is believed that reinfestation occurs primarily by the spread of beetles from improperly burned areas. A number of insecticides are being tested against both larval and adult stages. Of these, DDT, parathion and methoxychlor seem most promising.

*Weed Control.*—Kerosene at 2, 3, and 4 gallons per square rod and Stoddard Solvent at 1, 1½, and 2 gallons per square rod were tried on four different dates from early to late April. Kerosene had little effect on either weeds or blueberries. Stoddard Solvent had little effect on weeds and proved somewhat toxic to blueberries.

Borax at 3, 6, and 9 pounds per square rod, applied in April, was very toxic to all plants including the blueberries. However, there were some signs in the fall that the blueberries might be coming back on the plots with the 3 and 6 pound applications. The last of August another series of plots was laid out using borax at ½, 1, 2, and 3 pounds per square rod. Also, spot treatments were tried on a number of species using ¼ cup of borax per clump.

A comparison was made of the ammonium and sodium salts of 2,4-D at 250, 333, and 500 p.p.m. for the control of sweet fern. These salts appeared to be

equally effective in controlling sweet fern, and neither caused any observable injury to the blueberries. However, the 250 and 333 p.p.m. concentrations were too low to give good control, but 500 p.p.m. appeared effective.

The ammonium and sodium salts and two esters of 2,4-D and two esters of 2,4,5-T at 250, 333, and 500 p.p.m. were compared for the control of bayberry. Esteron 245, an ester of 2,4,5-T, appeared to be the most effective. Practically all tops were killed at 333 and 500 p.p.m. Some resprouting occurred in the spring of 1950.

In June a mixture of Dow Contact Herbicide (13 ounces) and kerosene (to make 1 gallon) was sprayed on the base of the trunks of poplars 2-5 feet high. The tops appeared to be killed but there was some evidence of resprouting late in the season. Painting this material on the trunks was not effective.

In September a number of species were treated with an ester of 2,4,5-T and a mixture of equal parts of an ester of 2,4-D and an ester of 2,4,5-T at 2500 p.p.m., also a GLF weedkiller (a mixture of 2,4-D and 2,4,5-T) at 1:40 as recommended by the manufacturer. All of these treatments killed gray birch.

### Chemical Control of Weeds in Fruit Plantings. (J. S. Bailey.)

*Strawberries.*—A series of plots in triplicate were treated with the sodium salt 2,4-D at  $\frac{1}{4}$ ,  $\frac{1}{2}$ ,  $\frac{3}{4}$ , and 1 pound per acre 11 days after the plants were set. The  $\frac{1}{4}$ ,  $\frac{1}{2}$ , and  $\frac{3}{4}$  pound treatments controlled broad-leaved weeds for three to four weeks and retarded the growth of grasses. One pound per acre held broad-leaved weeds for about six weeks. There was some evidence of slightly reduced growth resulting from the 2,4-D treatments, particularly the two heavier ones. The  $\frac{1}{4}$ ,  $\frac{1}{2}$ , and  $\frac{3}{4}$  pound per acre plots were re-treated 25 days after the first treatments. Broad-leaved weeds were held fairly well until June 20. Two applications at  $\frac{1}{2}$  or  $\frac{3}{4}$  pound per acre appeared slightly better than one application at 1 pound per acre. All plots were cultivated from June 20 to July 23 when the 2,4-D plots were re-treated. Weed counts made September 6 showed no reduction in number of weeds but there was a reduction in size of weeds, both broad-leaved and grasses.

On May 10 three plots were sprayed with Stoddard Solvent. The strawberry plants were protected by covering them with No. 10 cans. It gave good control of both broad-leaved weeds and grasses until June 20.

Sodium trichloroacetate at 10 pounds per acre gave good control of grasses but was too toxic to the strawberries.

Sodium pentachlorophenate at 10, 17.5, and 25 pounds per acre was tried as a preplanting treatment. Weeds were checked for 3 to 5 weeks. Strawberry plants showed chlorosis, particularly at 25 pounds per acre, which they outgrew later in the season. There was reduced growth of strawberries at 25 pounds per acre.

Pentachlorophenol in oil at 7, 10, and 13 pounds per acre was tried as a preplanting treatment, both before and after weed emergence. Post-emergence treatments were the most effective but this necessitated delay in the planting of the strawberries which is undesirable. Fuel oil alone appeared to be as effective as oil plus pentachlorophenol.

Isopropylphenylcarbamate at 10 pounds per acre applied in late October controlled chickweed but caused some injury to Catskill and severe injury to Howard strawberries. Applied in May at 10, 15, and 20 pounds per acre, it caused a chlorosis of the leaves and stunting of the plants which increased with increasing rate of application. There were varietal differences: Sparkle was affected the least and was nearly as good as the checks; Catskill, Robinson, Howard, and



Temple were about alike and much more affected than Sparkle; Wm. Belt was worst.

*Raspberries.*—Since sodium trichloroacetate applied in August caused a severe chlorosis and curling of raspberry leaves, another series of plots was laid out in November and treated at 20, 40, 60, and 80 pounds per acre. The 80-pound application reduced the quack grass stand by only 30 percent.

A small plot sprayed with Stoddard Solvent in June and August indicated that this material may have a place in weed control in raspberries.

*Blueberries.*—Sodium trichloroacetate applied in August, 1948, at 150 pounds per acre killed 75 percent of the bushes. Although applications at the rate of 37.5, 75, and 112.5 pounds per acre caused delayed foliation and chlorosis in 1949, the bushes have recovered and appear to be in good condition but their crop is light. Blueberry bushes in plots treated with sodium trichloroacetate in November, 1949, show chlorosis varying from slight at 12.5 pounds per acre to severe at 100 pounds per acre. TCA at 100 pounds per acre reduced the quack grass stand by about one half; 50 pounds or less gave little or no reduction in stand.

An application of Dow General (dinitro-ortho-secondary-butylphenol) was made in May at a rate to give 14-15 pounds of actual toxicant per acre, which is a very heavy rate. The leaves looked rather yellow and sickly for a couple of weeks but the bushes outgrew the injury and bore a good crop. This indicates that any reasonable application (around 3 pounds per acre) would be safe. Since this is a contact killer, it is effective against annual weeds but not against perennials like quack grass.

*Apples.*—A small block of apple trees on Malling 9 stocks was suffering from severe competition from a tough sod of creeping red fescue. Half the block was cultivated and half used to see if the sod could be suppressed by sodium trichloroacetate. Treatments were made May 2 at 0, 10, 20, and 40 pounds per acre. The trees were ring-fertilized. Where the fertilizer was applied it counteracted the effects of the TCA. The TCA, even at the lowest rate, caused a chlorosis of the leaves. The trees in the cultivated plot look much better and made better growth than those in any of the treated plots.

On November 5, 1945, TCA was applied around the trees in a young apple orchard at 50, 100, and 150 pounds per acre. No reduction in quack grass stand resulted from the 50 pound application; 100 or 150 pounds per acre reduced it 2/3 to 3/4.

*Peaches.*—Chemical "mowing" was tried in a contour peach orchard where the berms are covered by a tough quack-grass sod. A mixture consisting of Dow General (dinitro-ortho-secondary-butylphenol) 5 quarts, fuel oil 60 gallons, and water to make 400 gallons was used at the rate of about 200 gallons per acre. Three applications were made, one in late April, one in mid-May, and one in early July. The quack grass was killed to the ground but came back in about 3 or 4 weeks. Chemical "mowing" is faster than hand mowing. Two men with a power sprayer covered the orchard in half a day. It takes two men 4 or 5 days to do it by hand. However, if the grass is allowed to grow until the stems become tall and woody, they are left standing by the chemical and not only puncture dropped fruit but also are somewhat of a fire hazard. Therefore, to do a good job, chemical should be applied several times during the season, before the grass gets too tall.

## Studies of Varieties of Fruits. (W. D. Weeks and Staff.)

*Apples.*—Idared, a recent introduction from Idaho, fruited for the first time. It shows some promise as a winter apple, characterized by large size, high color, and good quality.

Davey revealed a rather serious weakness during the 1949 season in its tendency to crack. This trouble may be due to the hot dry season, but it must be taken into consideration in the final evaluation of the variety.

*Blueberries.*—Kenlate was imported from Nova Scotia, Canada, because it was supposed to be unusually late. The bush is small and dwarfish and although it bears a good crop for the size of the bush, the bush is too small to be a very heavy yielder. The fruit is only medium in size, fair in flavor, a little dark in color, and is not as late as was first supposed. It ripens ahead of such late varieties as Rubel and Jersey. It is probably of little use in this State.

Berkeley is a new variety which was named less than a year ago. The bush appears to be vigorous and productive; the fruit is exceptionally large, is an excellent blue color, and is very attractive, but the flavor is a bit mild. It ripens in mid-season with Concord and Pioneer.

Coville is another new variety named at the same time as Berkeley. The bush appears to be very vigorous and very productive. The fruit is large but not as large as that of Berkeley; it does not have such a light blue color but is very fine in flavor. It ripens late and looks like a promising variety.

*Raspberries.*—Some two hundred raspberry seedlings which were obtained from the New York Agricultural Experiment Station at Geneva, N. Y., fruited for the first time. Preliminary examination, based on size and quality, revealed several seedlings which are promising enough for further trial.

*Strawberries.*—Sioux appears to be a rather weak grower and not too good a plant maker. It ripens in mid-season. The fruits are rather small, lacking in flavor, and production was light. It does not look promising.

Robinson appears to be somewhat above medium in vigor and a fairly good plant maker. The fruits are medium to large in size, regular in shape, color evenly, and are attractive. However, the flavor is rather flat and insipid. It is noteworthy that June yellows appeared in this variety this year. The chief things to commend this variety are its plant-making ability and the fine appearance of the fruit.

Valentine. Plants of this variety are very vigorous and good plant makers. Fruit stems are long, thick, and erect so that they hold the fruits up well. The fruit ripens a little after midseason, is medium to large in size, regular, attractive, not too dark in color, firm, juicy, and of very good quality. It looks very promising.

Great Bay is a vigorous growing variety and good plant maker. The fruit stems are long, thick, and erect. The fruit matures late and is large and firm but is variable, irregular, and not very attractive. The berries are rather tender and juicy, a bit sour, and lacking in strawberry flavor. Some fruit rot was noted before the berries were ripe. Lateness seems to be the only outstanding characteristic of this variety.

Van Rouge. Plants of this variety are only medium in vigor although good plant makers but not too productive. The fruit matures in midseason, is small to medium in size, rather dark and unattractive; the flesh is firm and juicy but sour. The flavor is poor. The berries separate too easily from the stem. This variety does not look promising.

Fairpeake was very disappointing this season. The plants showed only medium vigor although fairly good plant makers and production was rather light. The fruit ripens late, is medium to small in size and rather variable, irregular, and unattractive with hard, undeveloped tips. The flesh was firm but rather dry, sour, and lacking in flavor.

Redcrop was also rather disappointing. The plants were only medium in vigor and not too good plant makers. The production was rather light. The stems were rather short and a bit slender so that the berries were on the ground. The fruit matured late and was rather small and variable in size although fairly attractive in appearance. The flesh is firm and juicy but rather sour and only fair in flavor.

Black. Plants of this variety are only medium in vigor but are good plant makers. Production was about medium. The fruit matures late and is large to medium but somewhat variable in size. It colors evenly and is very attractive in appearance. The flesh is firm and juicy although a little stringy, sweet and subacid, mild and agreeable in flavor. It seems worthy of further trial.

Superfection. Plants of this variety are rather weak and dwarfish but fairly good plant makers for an everbearer. Production appears to be light. The fruit is small and uniform in size and regular in shape. The berries color evenly, are medium red and attractive. However, the flesh is tender and juicy and very sour and poor in flavor. It does not look promising.

Brunes Marvel is another everbearer which is only medium in vigor and rather dwarfish in habit. It is a poor plant maker and production is light. The fruit is only medium and variable in size, regular in shape and attractive. The flesh is tender, rather dry, a bit sour and only fair in flavor. It does not look promising.

Elgin. Plants of this variety appear rather weak and dwarfish although good plant-makers. Production was only medium. It appears to be quite susceptible to leaf spot. The fruit matures very late, being one of the last berries to ripen. The fruit is large, uniform in size but irregular in shape, rather rough and not too attractive. The flesh is tender, a bit dry and sour with very poor flavor. Lateness is the only thing to recommend this variety.

Fairland is a very strong grower, an excellent plant maker and very productive. The fruit matures in early midseason, is large and uniform in size and regular in shape. The berries are very attractive, the flesh is very firm, juicy, and of fairly good quality although it is a little mild in flavor. It looks very promising.

*Peaches.*—Erly-Red-Fre is an unusually promising early peach. The fruit is medium to large in size, very well colored, and very attractive. The flesh is white, firm and has very good flavor for an early peach. It has a slight tendency to cling to the pit. This is the best early peach tried so far.

Fowler is a late peach, ripening with or a little ahead of Elberta. The trees are very vigorous but so far the crops have been very light. The fruit is yellow fleshed, large, round, attractive, well colored, firm, and freestone. The skin is rather thick and tough. It should be a good shipper. The flavor is fairly good. This variety deserves further trial.

Michigold. The tree is moderately vigorous and appears to be a heavy producer. The fruit ripens in late midseason, is large, attractive, yellow fleshed, and well colored. It is freestone with firm flesh but only fair quality. It deserves further trial.

**Study of Tree Characters of Fruit Varieties.** (W. D. Weeks, A. P. French, O. C. Roberts.) Buds of the Orient pear, a new introduction from Tennessee, were budded to obtain vegetative characters for nursery identification work. Orient



has some resemblance to Kieffer but differs from Kieffer by having fewer and larger lenticels which are russet instead of white. The growing tips of Orient are redder than Kieffer. Orient has a smaller and less folded leaf blade with an acuminate tip. The net veins are slightly raised, while those of Kieffer are depressed. Serrations are more prominent and sharper.

Field inspection of fruit tree nurseries for trueness-to-name was extended to Iowa and Missouri during the year. While the numbers of misnamed trees found were generally small, some sizable mixtures were found which could have resulted in serious loss to the nurserymen and grower if they had not been detected.

## DEPARTMENT OF POULTRY HUSBANDRY

Fred P. Jeffrey in Charge

**Broodiness in Poultry.** (F. A. Hays.) The broody instinct is of significant economic importance because broody periods are accompanied by a cessation of laying. In Rhode Island Reds bred for high fecundity this nonproductive period has averaged about 15 days for many generations. The increased incidence of broodiness in many crosses of strains and breeds has been observed by many workers. So far as we are aware, a completely non-broody line in any breed has never been established.

In this experiment selection of breeding stock is being made on the progeny test and on the reaction of each female to the prolactin hormone. The generation hatched in 1948 completed the first laying year with no evidence of broodiness. It is well known, however, that the instinct may be deferred to the second or third laying year, so that further tests are necessary and are being carried on. If the broody instinct can be completely eliminated by breeding methods, there would be an answer to an important economic problem.

**Genetic Laws Governing the Inheritance of High Fecundity in Domestic Fowl.** (F. A. Hays and E. W. Spear.) The many individual characters and factors that regulate egg production are being studied in a closed flock of pedigreed Rhode Island Reds. Inbreeding has been constantly avoided so that the degree of inbreeding amounts to about 5 percent, or below the estimate for random matings. Viability in the stock is being given constant attention together with a long series of other desirable characters.

Particular attention is now being directed toward reducing the variability in rate of laying. A study covering ten generations shows clearly that winter pause and winter intensity are intimately associated and that very high intensity tends to reduce the pause incidence and duration. Winter pause incidence shows a low degree of heritability, but pause duration has a much higher degree of heritability.

In the generation hatched in 1950, an intimate association appeared between hatchability and sex ratio of chicks. Hens that hatched from 90 to 100 percent of fertile eggs had 49 percent males at 8 weeks, compared with 55 percent males from hens with hatchability of 60 to 69 percent. This means that female embryos are less viable than male. Families of chicks with a high percentage of males were more viable to 8 weeks of age but this higher viability did not persist for the period from 8 weeks to 6 months or for the first laying year. There is evidence that significant progress can be made in raising the production level well above the present level of 232 eggs.

**A Study of Fertility Cycles in Males.** (F. A. Hays and E. W. Spear.) Definite evidence has been produced indicating that fertility is regulated by genes

transmitted from sire to daughter. Sires may be selected for high fertility either on the basis of the records they make with their mates or on the performance of their daughters. A recent study has shown that in natural matings some males fail to mate often enough with certain hens to insure a supply of fresh spermatozoa. The result is an abnormal increase in early embryonic deaths through the breeding season in some females.

Artificial light supplied at the rate of about 2 foot-candles on the floor has been more effective and more economical than sex hormones for activating old males.

A significant correlation between fertility and hatchability has appeared in recent generations. This association is believed to be produced by stale sperm

**Secondary and Adult Sex Ratio in Relation to Hatchability.** (F. A. Hays.) One line of Rhode Island Reds has been established that shows a mean hatchability of about 40 percent. A second line has been developed for high hatchability. There is a significant difference in the hatchability of these two lines. Particular attention is being devoted to the specific causes of low hatchability.

Females with highest hatchability give the lowest percentage of males because the female embryos are less viable than the male. When hatchability exceeds 90 percent, fewer males than females appear in the family.

Under our condition of incubation, early embryonic deaths tend to increase slightly through the March and April hatching period. Evidence indicates that this increase is due to infrequent matings between some birds and not to incubation conditions.

**The Development of Inbred Lines of White Plymouth Rocks.** (F. P. Jeffrey and J. Robert Smyth, Jr.) Fourteen inbred lines of White Plymouth Rocks are being developed. During the first year of brother x sister matings the hatchability of total eggs set was 60 percent as compared to 77 percent in the random-bred flock of White Plymouth Rocks. During the 1950 brooding season all inbred chicks received heavy exposure to bronchitis and an unknown "respiratory disease." Six-week mortality among sire progenies ranged from 29 to 66 percent. Only one family showed 100 percent livability, whereas six families had mortality exceeding 90 percent.

**Genetics and Physiology of the Length of Incubation Period in the Domestic Fowl.** (J. Robert Smyth, Jr.) Observations were made on the emergence time of White Plymouth Rock chicks at six-hour intervals during the twentieth, twenty-first, and twenty-second days following the start of incubation. These observations were made on the offspring from three single male matings and the chicks were pedigreed and raised for observation and future breeding stock. Divergent lines in respect to emergence time will be developed for future study by mating the early hatching with early hatching individuals and late hatching with late hatching individuals.

The average emergence time of the present generation was 21 days and 19 hours after the eggs were set in the incubator. The chicks hatched over a period of 48 hours beginning at 20 days and 18 hours and ending at 22 days and 18 hours. Chicks hatching during the first third of this period represented 12.3 percent of the total while 69.8 percent emerged during the middle third and 17.9 percent during the last third.

No significant correlation was found between the time of emergence and the sex of the chick or between livability to five months of age and emergence time, although the early emerging chicks showed a slightly higher percentage of livability. The exposure of this stock while very young to a chronic respiratory

disease and the resulting mortality could have masked any inherent differences between the early and late emerging groups in resisting causes of death normally encountered.

Although male families showed no statistically significant differences for emergence time, dam families showed highly significant differences. The average emergence time for dam families ranged from 21 days and 9 hours to 22 days and 4 hours after the onset of incubation.

**The Effect of Sperm Survival Time in the Female Reproductive Tract on Fertility and Hatchability in the Fowl.** (J. Robert Smyth, Jr.) Observations are still being made on the sperm survival time in the oviduct of the fowl for six White Plymouth Rock males, each of which is being mated to the same 60 White Plymouth Rock females. The offspring are being individually pedigreed on the basis of both sire and dam and the age of the fertilizing sperm cell. These pedigreed chicks will form the foundation stock for the study in 1951. At the present time the data collected are not complete enough to warrant any conclusions.

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### SEED CONTROL

Frederick A. McLaughlin in Charge

Enforcement of the Seed Law, together with the desire of seedsmen to comply with requirements of this Act, and a growing interest of the public in good seed, resulted in a large number of service samples being sent to the Seed Laboratory for testing. From July 1, 1949, to June 30, 1950, 6151 service and inspection samples of seed were received and worked at the laboratory. The laboratory also received and cleaned 78 lots of tobacco seed.

Analysis of inspection samples shows that most seedsmen have complied with label requirements of the Seed Law. A large part of the violations found are technical in nature rather than flagrant.

Operation of the Seed Law is reported in an annual bulletin issued for that purpose.

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### SHADE TREE LABORATORIES

Malcolm A. McKenzie in Charge

**Diseases of Trees in Massachusetts.** (M. A. McKenzie, A. Vincent Osmun, and D. H. Marsden.)

*Dutch Elm Disease.* From July 1, 1949, to June 22, 1950, the Dutch elm disease was found in 49 additional towns, making a cumulative total of 183 since the disease was first known here (1941, Alford, Berkshire County). Summarily, in laboratory studies by means of tissue plantings in artificial culture media, the disease fungus, *Ceratostomella ulmi* (Schwarz) Buisman, has been isolated from 6498 trees in 11 of the 12 counties on the mainland, Barnstable, Dukes, and Nantucket being reported disease-free at present.

Current investigations indicate the importance of completion of adequate sanitary operations promptly. Delay in removing and burning diseased trees may result in expanding disease spread and costs of control. The use of spray materials to restrict vectors of the disease fungus may be a valuable adjunct to Dutch elm disease control by sanitation methods. Studies to this end are in progress in cooperative investigations with the Department of Entomology.

Study of disease resistance in elms offers another challenge to the spread of the disease. But reliance should not be placed in propagation from a single disease-



resistant tree. Such progeny may not constitute a permanent answer for satisfactory shade trees. Diseases previously known to cause only slight damage may become serious with the test of time. Also, disease-producing organisms themselves may undergo parallel readjustment and survive as parasites of changing host.

Popular opinion relative to the significance of the disease has ranged from complete indifference to utter despair. Both extremes are at variance with known facts relative to the disease and could nullify, in part at least, constructive efforts for restricting disease spread and checking the decimation of American Elms, as inherent and congruous in the New England scene as the familiar village greens of which they may be a part.

To wishful thinkers who rationalize blindly "There is no such thing as Dutch elm disease," stark tree skeletons and barrenness are undeniable refutations evident in casual observation not far beyond State boundaries of the Commonwealth. Massachusetts cherishes her elms far beyond any monetary estimate which might be placed upon them, but some idea of the investment in dollars may help all of her citizens to appreciate more fully the true worth of her principal shade tree. In a recent elm census report, the value estimated for the elms in four Massachusetts cities and towns was conservatively placed at \$7,300,000.

To mournful fatalists who decry elm extinction as inevitable, a critical review of the situation throughout Massachusetts should abate considerably the panic of frustration.

Studies of conditions throughout the State indicate that some towns where elms occur almost exclusively as cared-for shade trees can, with proper consideration to ordinary maintenance, avoid extensive loss of elms. In such areas, living with the Dutch elm disease should not involve losses much in excess of losses already known in connection with native tree diseases.

For communities where a large percentage of the elms are wild trees, in such favorable elm sites as Housatonic, Connecticut, and Merrimac Valleys, further study is needed to achieve a satisfactory balance for living with the disease.

In the meantime, restricting the extensive planting of elms, except where conditions are favorable locally, may be a basis for utilizing more fully other suitable plant materials in new real-estate developments and otherwise. The dangers of planting exclusively a single species or variety of tree should be apparent from familiar local and world-wide tragic experience with the Dutch elm disease.

Nine progress reports (mimeographed) and nine press releases were sent out during the year.

*Tree Problems in New Highway and Real-Estate Developments.* Increased activity in construction of buildings, walks, highways, and related accommodations has created a variety of tree-maintenance problems. In some communities serious tree losses are inevitable in current highway and other construction. Necessary as these operations may be, losses often represent irreplaceable trees and no alternative for the tree cutting or damage should be discarded without exhaustive consideration. Trees are valuable citizens and constitute an important part of taxable property. When the number of trees cut in a community exceeds the number of trees planted, the community faces a disaster of considerable significance. Trees in many towns may be the common denominator of all generations, and they can make the difference between mediocrity and superiority. They are often the only beauty in an otherwise dismal setting.

Investigations have shown wide variations in specific causes for disorders of trees involved in construction operations, and case histories indicate that condi-

tions are often peculiar to individual sites. To this extent each tree is unique, but problems encountered most commonly under general and particular conditions are:

1. Failure of trees already established previous to construction work.
2. Failure of trees planted following construction work.
3. Failure of single trees left when most trees are cleared from an area.
4. Mechanical injury to tree roots.
5. Mutilation by construction machinery or operations.
6. Trees not suited to small space allotted in crowded multi-unit real-estate developments.
7. Poor drainage.
8. Improper use of fill about tree trunks.
9. Significant rise or fall in water table.
10. Frost cracks.
11. Slime flux.
12. Drought.
13. Winter injury.
14. Lightning.
15. Illuminating gas in soil from break in gas main.
16. Fire scars from burning rubbish near by.
17. Pests emanating from accumulation of cut trees.

*Other Tree Problems.* Forty-three diseases of twenty-eight species of trees including nine diseases of elms were identified from more than 1250 specimens and inquiries during the year. Wilt diseases of elm which under certain conditions may be confused with Dutch elm disease, have been found widely throughout the State, especially in association with the fungi *Cephalosporium* sp. and *Verticillium* sp. The latter fungus has also been isolated frequently from other diseased woody plants concerning which correspondents have requested information.

Extended periods of dry weather resulted in direct injury to certain plants and also contributed to damage by fungi and insects, notably on evergreens.

A disease of mockorange (*Philadelphus* spp.) continues to attract wide attention throughout Massachusetts. No part of the State appears free from the trouble which is most conspicuous as unsightly dead stalks on older shrubs. Appearance of affected plants suggests that a pathogenic organism is the cause of the trouble, but none has been identified as yet.

The disease of maples in which bronzed flags develop from foliage on maples was not so much in evidence during the past year. Wet weather is thought to favor its development and dry weather may have restricted it.

Widespread inquiries have been received relative to a disease of oaks reported to be caused by the fungus *Chalara quercina* in certain midwestern states, but the fungus has not been isolated in laboratory studies here. The cause for death of oaks in Massachusetts, reported to be increasing, has not been determined or investigated.

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## DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

**Poultry Disease Control Service.** (H. Van Roekel, K. L. Bullis, G. H. Snoeyenbos, O. S. Flint, M. K. Clarke, O. M. Olesiuk, A. M. Crotty, and C. D. Brandt.)

1. *Pullorum Disease Eradication.*—A total of 579 chicken, turkey, pheasant, and quail flocks was tested during the 1949-50 testing season. The number of

samples tested was the largest currently on record in the testing history for Massachusetts (1,444,364 chicken and 30,840 fowl other than chicken). The percentage of reactors (0.06) was slightly higher than that of the previous season. The percentage of "breaks" (4.82) also was higher. However, 98.20 percent of all birds tested were in 100 percent tested, non-reacting flocks. Ten flocks were classified as infected at the close of the season.

A more detailed discussion of the pullorum testing work is given in the Thirtieth Annual Report of Pullorum Disease Eradication in Massachusetts.

2. *Salmonella Pullorum* Studies.—Antigen variation in *S. pullorum* chiefly involves the XII<sub>2</sub> and XII<sub>3</sub> antigens. The IX and XII antigens are relatively constant. A standard form culture contains a strong XII<sub>3</sub> and a weak XII<sub>2</sub> component. Essentially the opposite exists in variant forms. Some infected birds produce diagnostic levels of circulating agglutinins to only the XII<sub>2</sub> or XII<sub>3</sub> antigen. For this reason an infected bird may react only with antigens of similar antigenic structure. This fact is of marked significance to a control laboratory and is the justification for the investigational work being done on this problem.

Work has been continued during the year to determine the extent and importance of antigenic variation in relation to control testing methods. As was done last year, all cultures isolated at this Station have been comprehensively studied in relation to their antigenic composition. Of a total of 249 cultures isolated from 40 flocks, only 25 cultures from 3 flocks were found to be variants. Two of these three infections were in chicks purchased out-of-State and the third was an infection thought to originate from stock that did not have a pullorum-clean rating.

Although the antigen now in use occasionally fails to detect an infected bird, its over-all efficiency under our conditions is considered to be satisfactory and actually superior in application to any variant-containing antigen now in use. This conclusion has been reached after making over 25,000 tests in the past year with various experimental antigens in duplicate with our routine antigen.

3. *Diagnostic Service*.—During the 1949 calendar year, 7,096 specimens were received in 1,518 consignments of which 1,038 were delivered in person. This represents nearly a 50 percent increase over any previous year and reflects the increased interest in and incidence of respiratory infections, which will be discussed further in another section of this report. The specimens received were classified as follows: 6,475 chickens, 516 turkeys, 20 pheasants, 15 chinchillas, 12 chicken eggs, 10 mink, 9 ducks, 7 pigeons, 6 swine, 5 each of canine feces and bovine, 3 quail, 2 each of deer, finches, geese, and ruffed grouse, and 1 each of canine blood, owl, pea fowl, rabbit, and wildcat.

Fowl paralysis was diagnosed in nearly twice as many instances as in the previous year, but this was not taken as an indication of a true increase in the incidence of the disease.

Sulfaquinoxaline was available for continuous low-level feeding as an aid in preventing coccidiosis and was widely used during the year. There were nearly as many diagnoses of coccidiosis as in previous years, but the outbreaks were modified in character and were milder.

Keratocconjunctivitis—a newly reported disturbance during the past few years and still believed due to litter and ventilation conditions, with particular reference to ammonia fumes—was identified more frequently than formerly.

There were 44 diagnoses of fowl typhoid and 21 of fowl cholera, 35 and 14, respectively, representing new known foci of infection. The incidence of both diseases was higher, but the fowl typhoid was of particular concern, as more than twice as many cases were identified and four communities sustained outbreaks



which involved several neighboring farms. An outbreak of fowl cholera in pheasants apparently was successfully eradicated through depopulation. Avian tuberculosis was identified in two flocks.

Fifteen chinchillas were examined, but a satisfactory herd diagnosis was not made. The larval stage of the dog tapeworm, *Multiceps serialis* (identified by the Zoological Division, B.A.I., U.S.D.A.) was found in a three-year-old female chinchilla. *Dirofilaria immitis* was found in one dog.

The 516 turkeys were received in 92 consignments. Pullorum disease was identified once and paratyphoid twice. In contrast, there were three diagnoses of fowl cholera and six of fowl typhoid. Newcastle disease was recognized in four cases. The effect on egg production was not as marked as in most outbreaks in chickens. There were no outbreaks in very young poults, and mortality was not severe. *Aspergillus fumigatus* was recovered from the cerebrums of poults in one case which showed incoordination suggestive of Newcastle disease. For the fourth consecutive year, fowl pox in turkeys was not brought to the attention of the laboratory.

4. *Flock Mortality Studies*.—Up to January 1, 1950, necropsies were performed on 231 birds (197 females and 34 males) from the flock hatched in 1948 and maintained for genetic studies by the Poultry Department of the Experiment Station. Reproductive disorders (57), cannibalism (34), injury (34), alimentary disorders (30), and kidney disorders (24) were the most common diagnoses. The population had a relatively low incidence of tumors—leionyoma (5), lymphocytoma (5), myelocytoma (1), hemangioma (1), and fowl paralysis (5). Hjörre's disease (coli-granuloma) has been recognized in from one to five birds in eight of the past ten populations. In the group hatched in 1948, 13 females were found to be affected.

5. *Infectious Bronchitis Control*.—(a) Respiratory diseases, especially infectious bronchitis, Newcastle disease, and chronic respiratory disease, continue to be of great economic concern to the Massachusetts poultry industry. During 1949 a total of 944 flocks was enrolled in the infectious bronchitis control program, an increase of 536 flocks over the previous year. The results on the whole continued to be satisfactory. In a few instances complications developed as the result of secondary or concurrent diseases appearing in the flock. In a small number of inoculated flocks a respiratory disease appeared several months after the inoculation, and the virus of infectious bronchitis was isolated. It is evident that not all inoculated flocks develop full protection against the virus.

(b) During 1949 a total of 384 flocks was tested for immunity to infectious bronchitis. The diagnoses for the flocks were as follows: 334 immune, 27 susceptible, 12 questionable, and 11 with both immune and susceptible birds in the same flock. The 334 bronchitis-immune flocks were also tested for Newcastle disease, yielding the following results: 88 immune, 223 susceptible, 2 questionable, and 21 with both immune and susceptible birds on the same premises. Of the 27 bronchitis susceptible flocks 18 were susceptible to Newcastle disease and the remainder were immune.

(c) Among the 724 flocks tested for Newcastle disease, using the hemagglutination-inhibition test, 425 were susceptible, 228 immune, 7 questionable, and 64 had both susceptible and immune birds on the premises.

(d) Virus isolation for a differential diagnosis in respiratory cases was attempted in consignments from 44 flocks and yielded the following results: Newcastle disease 17, infectious bronchitis 2, laryngotracheitis 2, and chronic respiratory disease 2. More than half of the cases from which the Newcastle disease virus was isolated represented flocks which had been vaccinated for the disease.

Apparently the immunity induced through vaccination was inadequate to withstand natural exposure to the virus. In the majority of cases the disease was of a mild type.

(e) Viability studies concerning Newcastle disease revealed that the virus, when seeded on various sterile test materials and stored at different temperature levels, remained viable for long periods of time. The virus seeded on down and in fresh eggs was found viable for the following periods of time when stored at the different temperature levels: incubator (37°C), 126 and 87 days, respectively; normal room (20° to 30°C), 235 and 192 days, respectively; hen house (-11° to 30°C), 255 days, refrigerator (3° - 6°C), 538 days. The viability time period listed at the refrigerator temperature represented the last test made and not the end point for the viability of the virus. The results of these investigations suggest that Newcastle virus may be highly resistant to certain environmental conditions, which may have a significant influence in the transmission and control of the disease. The results of these investigations are in press.

6. *Newcastle Disease Immunization Studies.*—(S. B. Hitchner and G. Reising.) Continued studies on the antigenic properties of a low virulent strain of Newcastle disease virus (B1 strain) showed that the wing web route of administration did not produce adequate immunity in comparison to the intranasal route. Field tests in laying flocks with this type of vaccine have demonstrated its applicability in checking outbreaks of the disease if given prior to the appearance of symptoms. The intranasal vaccination of day-old chicks, even though possessing some parental immunity, apparently increased the resistance of a high percentage of the chicks to re-exposure to the virus. Although vaccinated chicks may show low or negative serum antibody titers, laboratory tests reveal that upon re-exposure to infection most vaccinated chicks developed antibodies more rapidly than non-vaccinated chicks.

A study of the protection of chicks by passive antibodies showed that the disease could be produced in approximately 70 percent of the chicks by challenge exposure at one day of age. The results indicated that the passive protection against the disease decreased in the chicks as time elapsed from the date of vaccination of the parents, and that only those chicks from dams carrying very high antibody titers were fully protected against infection at one day of age.

During cultivation of the B1 virus in embryonated eggs it was observed that by using embryos from Newcastle immune flocks the mortality of the embryos was delayed beyond that of the embryos from non-immune flocks. Comparison of the growth rate of the virus in Newcastle disease immune and non-immune embryos demonstrated that there was very little difference in the virus concentration in the two groups even though mortality was delayed in the immune embryos.

**Mastitis Testing Laboratory.** (W. K. Harris and F. A. Goulet.) During the fiscal year of 1949-50 a total of 34,735 milk samples was tested. Of this number, 22,218 were from 21 State Institution herds, 922 from the University Farm Department herd, and 11,595 from 153 private herds. Included in the latter were 344 samples from one county agricultural school herd, 29 from seven goat herds, and 3,257 from nine demonstration herds. In addition to the total number of samples tested, 107 were received in a condition unsuitable for testing. Approximately 90 percent of all samples received were collected and delivered by State Department of Agriculture collectors.

The percentage of *Str. agalactiae*-infected cows in the State Institution herds has been reduced from 22 last year to 11, but the total number of mastitis-positive cows is the same, representing 39 percent of the cows tested. Three more herds

nave become free of *Str. agalactiae* infection making a total of seven. These herds contain approximately one-fourth of the cows in the 21 herds.

Since March 24, 1947, the University Farm Department herd has been given 14 complete tests, averaging 61 head per test. An average of 72.9 percent was found negative, 25.6 percent positive for mastitis other than *Str. agalactiae* infection, and 1.5 percent positive for *Str. agalactiae* infection. The first finding of the latter occurred in December, 1947, and the last in May, 1948. Prompt detection of all *Str. agalactiae*-infected cows by laboratory retesting, immediate measures taken to prevent spread of the infection, and successful mammary therapy have proved effective in eliminating the infection from the herd. Ten cows were found positive to the *Str. agalactiae* infection during this six-months period, but none have been found since. Five of the cows were slaughtered within a year after the last case was detected, but the other five remain in the herd more than two years later.

A summary of initial tests of private herds revealed an increase during the fiscal year in the percentage of infected cows. The average for the three-year period (1947-50) is 45.5 percent and represents the incidence of mastitis in the State, if it is assumed that the laboratory has received representative samples. On the same basis the incidence of *Str. agalactiae* infection is 25.0 percent, amounting to more than one-half of the positive cases. A total of 296 reports was made on samples from private herds. The average testing time (between receipt of samples and completion of report) for the year on private herd tests was three and one-half calendar days.

The county agricultural school herd has shown gradual improvement with a program of testing quarter samples at 90-day intervals during the last two years. The number of *Str. agalactiae*-infected cows has been reduced from 11 in a herd of 18 to 1 in a herd of 23.

A summary of tests made during the fiscal years 1947-50 on 37 animals from 12 goat herds reveals that only 20 percent were found positive for mastitis, and no infection with *Str. agalactiae* was found.

Three of the demonstration herds have been tested for more than a year and have increased from a total of 49 to 69 head. The percentage of *Str. agalactiae*-infected cows has been reduced from 38.8 to 4.3 and of all mastitis infections from 57.2 to 33.3.

Observations on individual herd progress in mastitis control indicate that good management and sanitary practices are essential, with emphasis on prevention of spread and complete herd retesting in attempting to eliminate *Str. agalactiae* infection.

## PUBLICATIONS

### Bulletins

- 437 Home Freezing in Massachusetts. By William B. Esselen, Jr., Katherine M. Lawler, and Carl R. Fellers. 35 pp. illus. February 1950. (Reprinted.)

Home freezing of foods is arousing much interest. In Massachusetts freezing seems best suited as a supplement to other methods of home food preservation. Questions frequently asked by prospective home freezer owners are answered.

- 453 Annual Report for the Fiscal Year Ending June 30, 1949. 86 pp. August 1949.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.



- 454 Marketing Massachusetts Potatoes. Part I. Potato Storage Facilities. By Robert A. Fitzpatrick. 32 pp. illus. January 1950.

Although Massachusetts is a deficient area in potato production, potatoes are one of the leading cash crops in the State; and the recent national experience in potato production and marketing has been duplicated, in miniature, here. This study was undertaken to contribute to a wider public understanding of the wartime and postwar developments in the local potato enterprise.

- 455 The Control of Some Soil-Borne Disease of Plants by Fungicides Applied to the Soil in Fertilizer. By William L. Doran. 28 pp. illus. March 1950.

The methods described for the control of such soil-borne diseases as clubroot of cabbage, smut of onion and damping-off of seedlings should be of special interest and value to growers of vegetables.

- 456 Heat Penetration and Processing Studies on Home-Canned Corn, Hominy, Pork and Beans, and Potatoes. By Norman W. Desrosier and William B. Esselen, Jr. 23 pp. illus. June 1950.

In response to a continuing interest in home food preservation, procedures for the home canning of hominy, pork and beans, and potatoes are presented. Factors which affect the process requirements of these low-acid foods are pointed out.

### Control Bulletins

- 140 Inspection of Commercial Feedstuffs. By Feed Control Service Staff. 28 pp. June 1949.

This is the fifty-fifth report on feeding stuffs inspection. Included are data on the vitamin D content of fish liver oils, the carotene and riboflavin content of alfalfa meals, and the quality of ground oats, as well as other information of interest to those concerned with the production, distribution or use of feeds.

- 141 Twenty-ninth Annual Report of Pullorum Disease Eradication in Massachusetts. By the Poultry Disease Control Laboratory. 11 pp. July 1949.

During the 1948-49 testing season 569 chicken, turkey, and pheasant flocks were tested. A total of 1,241,500 samples was tested, of which only 0.04 percent were positive. This is the lowest percentage of positive tests for the twenty-nine years of testing. The percentage (1.55) of pullorum "breaks" in the negative flocks was the lowest for the past ten years. Furthermore, 99.1 percent of all the birds tested were located in 100 percent tested, non-reacting flocks. Massachusetts flock owners are to be complimented on the progress that is being made in establishing and maintaining pullorum-free flocks.

- 142 Inspection of Commercial Fertilizers and Agricultural Lime Products. By Fertilizer Control Service Staff. 19 pp. July 1949.

This is the seventy-sixth report of the Massachusetts Fertilizer Control made in accordance with Chapter 94, Sections 250 to 261 inclusive, of Massachusetts General Laws 1920, as amended by Chapter 67, Acts of 1933.

- 143 Seed Inspection. By Seed Control Service Staff. 32 pp. November 1949.

This report, the twenty-second in seed control service, is a record of work delegated to the Massachusetts Agricultural Experiment Station during 1949 by authority of Chapter 94 as amended by Chapter 377 of the Acts of 1946.

### Meteorological Bulletins

#### NUMBERED CONTRIBUTIONS

- 724-732, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By H. N. Stapleton. 4 pp. each.

## Reports of Investigations in Journals

- 673 Nonenzymatic browning of foodstuffs. Production of carbon dioxide. By V. M. Lewis, W. B. Esselen, Jr., and C. R. Fellers. *Indus. and Eng. Chem.* 41:2587. 1949.
- 678 Nonenzymatic browning of foodstuffs. Nitrogen-free carboxylic acids in the browning reaction. By V. M. Lewis, W. B. Esselen, Jr., and C. R. Fellers. *Indus. and Eng. Chem.* 41:2591. 1949.
- 680 Enzyme systems of canned acid foods. Effect of processing conditions of time and temperature. By Arthur M. Kaplan, William B. Esselen, Jr., and Carl R. Fellers. *Indus. and Engin. Chem.* 41:2017. 1949.
- 685 The effect of maturity and storage on germination of Butternut squash seed. By Robert E. Young. *Amer. Soc. Hort. Sci. Proc.* 53:345-346. 1949.
- 686 Inbreeding in a closed flock. By F. A. Hays and D. W. Talmadge. *Genetics* 34:390-394. 1949.
- 688 The vegetative propagation of a few species of elm. By William L. Doran and Malcolm A. McKenzie. *Jour. Forestry* 47 (10):810-812. 1949.
- 691 Reduced ascorbic acid in goat's milk. By Arthur D. Holmes, Harry G. Lindquist, and Eugene J. Finnegan. *Jour. Amer. Dietet. Assoc.* 26 (3): 179-181. 1950.
- 692 Weed control in onions grown from sets. By William H. Lachman. *Amer. Soc. Hort. Sci. Proc.* 54 (1949):429-434. 1950.
- 693 Detergent sanitizers. By W. S. Mueller. *Jour. Milk and Food Tech.* 12 (4):240-243. 1949.
- 696 Storage studies on active dried bakers' yeast. By Roy E. Morse and Carl R. Fellers. *Food Tech.* 3 (7):234-236. 1949.
- 698 Off-flavors in peaches sprayed with benzene hexachloride. By John S. Bailey, William B. Esselen, Jr., and Ellsworth H. Wheeler. *Jour. Econ. Ent.* 42 (5):774-776. 1949.
- 699 Canceled.
- 700 Preparation of sterile fish muscle press juice for chemical and bacteriological studies. By David W. Anderson, Jr., and Carl R. Fellers. *Food Tech.* 3 (8):274. 1949.
- 701 Chemical thinning of apples at blossom time and up to four weeks from petal fall. By F. W. Southwick and W. D. Weeks. *Amer. Soc. Hort. Sci. Proc.* 53:143-147. 1949.
- 702 Further studies on the influence of methyl a-naphthaleneacetate on ripening of apples and peaches. By F. W. Southwick. *Amer. Soc. Hort. Sci. Proc.* 53:169-173. 1949.
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- 704 Weeding corn with chemicals. By William H. Lachman. *Amer. Soc. Hort. Sci. Proc.* 54:(1949):417-428. 1950.
- 705 Loss of reduced ascorbic acid from riboflavin-enriched mares' milk. By Arthur D. Holmes. *Food Tech.* 3 (8):277-278. 1949.
- 707 Mortality rate in relation to egg production. By F. A. Hays. *Poultry Sci.* 28 (5):707-712. 1949.
- 708 Composition and nature of apple protein. By S. G. Davis, C. R. Fellers, and W. B. Esselen, Jr. *Food Res.* 14 (5):417-428. 1949.
- 710 Winter injury to red raspberries as affected by cultivation or mulching. By John S. Bailey. *Amer. Soc. Hort. Sci. Proc.* 54 (1949):197-199. 1950.

- 711 The nutritional status of the cultivated blueberry as revealed by leaf analysis. By John S. Bailey, C. Tyson Smith, and Robert T. Wetherbee. *Amer. Soc. Hort. Sci. Proc.* 54 (1949):205-208. 1950.
- 712 Comparison of light vs. darkness for storing Butternut squashes. By Arthur D. Holmes, Albert F. Spelman and Robert T. Wetherbee. *Food Tech.* 3 (8):269-271. 1949.
- 713 Decrease of reduced ascorbic acid in goat's milk during storage. By Arthur D. Holmes. *Food Res.* 14 (6):468-471. 1949.
- 716 Some antigenic characteristics of *Salmonella pullorum*. By G. H. Snoeyenbos, A. M. Crotty, and H. Van Roekel. *Amer. Jour. Vet. Res.* 11 (39): 221-225. 1950.
- 717 Fixation of ammonia by lignin. By Emmett Bennett. *Soil Sci.* 68 (5): 399-400. 1949.
- 718 Rate of destruction of reduced ascorbic acid in riboflavin-fortified pasteurized milk. By Arthur D. Holmes. *Food Tech.* 4 (3):92-93. 1950.
- 719 Preservation of Russian caviar by canning. By A. S. Levine, C. R. Fellers, and R. R. Barton. *Food Tech.* 4 (1):15-16. 1950.
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- 721 Temperature and viability as related to winter pause incidence and duration. F. A. Hays. *Poultry Sci.* 28 (6):894-897. 1949.
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- 727 Nickel in cows' milk. By J. G. Archibald. *Jour. Dairy Sci.* 32 (10):877-880. 1949.
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- 732 Is fertility in domestic fowl regulated by inheritance? By F. A. Hays. *Poultry Sci.* 29 (2):171-175. 1950.
- 733 Method for determining relative phosphate-fixing capacity of acid soils. By Garland B. Bass and Dale H. Sieling. *Soil Sci.* 69 (4):269-280. 1950.
- 734 The value of annual egg records in breeding poultry for high fecundity. By F. A. Hays. *Poultry Sci.* 29 (2):190-192. 1950.
- 735 Further studies on viability in Rhode Island Reds. By F. A. Hays. *Poultry Sci.* 29 (2):193-194. 1950.
- 736 Effect of organic anions on phosphate precipitation by iron and aluminum as influenced by pH. By Paul H. Struthers and Dale H. Sieling. *Soil Sci.* 69 (3):205-213. 1950.
- 737 The relationship between egg shell color and incidence of colored meat spots. By F. P. Jeffrey and C. E. Walker. *Poultry Sci.* 29 (2):244-247. 1950.
- 738 Mustard as a preservative for fruit juices. By O. Kosker, Carl R. Fellers and W. B. Esselen, Jr. *The Glass Packer*, November 1949.



- 739 Thermal destruction and stability of peroxidase in acid foods. By Edward A. Nebesky, William B. Esselen, Jr., A. M. Kaplan, and Carl R. Fellers. Food Res. 15 (2):1-11. 1950.
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- 749 Relative capacity of soils to furnish ions to plants. By Walter S. Eisenmenger. Jour. Forestry 48 (6):416-418. 1950.
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- 752 A micro method for evaluating germicides by determining 100 per cent kill. By William S. Mueller. Mod. Sanit. 2 (6):45-46. 1950.
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- Meeting the hay shortage. By J. G. Archibald. Eastern States Cooperator 25 (10):5-7. October 1949.
- Results of tests with fungicides, 1949. By E. F. Guba. Mass. Fruit Growers Assoc. 56th Ann. Rept. January 1950.
- Fungicidal soil treatments for controlling carnation stem rot and wilt diseases. By E. F. Guba. Carnation Craft for September 1949, pp. 7-8.
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- Vegetable Pest Control Charts. By A. I. Bourne, with O. C. Boyd and E. H. Wheeler. (Revised 1950.)
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AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 466

SEPTEMBER 1951

## Annual Report

For the Fiscal Year Ending June 30, 1951

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The main purpose of this report is to provide an opportunity for presenting in published form recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

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CROWLEY, DENIS M., Boston	1959

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GARDNER, GRACE, *Pomology*  
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# ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1950-1951

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## DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

**Study of Farm Real Estate, Taxation Methods of Taxation Reform, and the Effect of Such Measures on Farm Income.** (A. A. Brown and R. A. Fitzpatrick.) In Massachusetts, land accounts for 45 percent of the total real estate valuation of dairy farms, but marked variability exists in the productivity of the land in the farms. Land utilization, basically, is a function of soil type, and soil types differ among farms and parcels of land in the farm. Consequently, farms differ in their capacity to produce income. For tax purposes, however, a lump sum is placed on all the land in the farm. Such procedure results in over-assessment of the least productive and under-assessment of the most productive land.

The matter of devising objective methods for evaluating farm land is one which is receiving considerable attention here and in other parts of the country. In Hampshire County, a classification of sample dairy farms has been initiated and will serve as the basis for computing a set of tax values. The hypothetical set of values will be compared with the assessors' uniform values in order to appraise the relative merits of the two systems.

**Production Adjustments on Representative Massachusetts Farms.** (Bradford D. Crossmon, H. Russell Shaw, and Elmar Jarvesoo.) Farm management case studies are being continued on 47 selected Massachusetts farms. Dairy and poultry farms and cranberry bog operations have received the most study to date. Periodical checkups indicate that most of the farms have already made considerable adjustments in line with their farm development plans. Increased cow numbers, higher production per cow, and more and better home-grown roughage are the most common changes.

The study of portable pipe irrigation on hay and pasture crops was continued during the summer of 1950. Inasmuch as irrigation on grassland is an expensive measure in Massachusetts, every farmer planning the installation of such a system should consider other alternatives, such as increased fertilization per acre and purchase of additional land, which appear to be cheaper ways of securing additional roughage over a period of years.

**Fluid Milk Prices.** (A. A. Brown, V. J. Pierce, and H. G. Spindler.) Analyses of supply areas and price relationships of major Northeast milk markets and secondary markets of Massachusetts have brought out certain facts and conclusions that appear valid at this time:



1. Price differences between markets, based on the location theory of pricing make possible the alignment of regulated prices on the basis of transfer costs.

2. The supply area should include two separate zones: (1) a fluid supply zone extending from the market area just far enough to fulfill the fluid demands from the nearest available supplies, and (2) the most distant cream powder zones. For the Northeast, transportation costs can be minimized by using the nearest supplies for fluid purposes, thereby permitting lower prices to consumers and higher prices to producers.

3. The differences in prices between markets accounted for by transportation costs are relatively small. The farm supply prices are lower but appear to vary more than market prices.

**Marketing of Hatching Eggs.** (A. A. Brown and R. W. Brundage.) A report based on the experience of 81 broiler-hatching egg producers entitled "Broiler Hatching Egg Marketing by Massachusetts Poultrymen — The 1949 Season" was issued in February 1951. Of the many problems faced by these producers, the most important was the irregularity of marketing. Over-supply and then under-supply resulted because of the failure or inability of broiler processors and growers to anticipate the demand for broiler meat. These shifts appear to be reflected in the changing demand for broiler-hatching eggs. Integrated systems in which the processor or the feed man fills the critical role have been developed in an attempt to cope with the "boom or bust" characteristics of the industry. In either instance, control of marketings may extend from the processing plant through the hatchery to the breeder. The solution, however, has its disadvantages.

**Marketing Massachusetts Potatoes.** (R. A. Fitzpatrick and A. A. Brown.) The main barrier in potato marketing has been the justifiable reluctance of growers to publicize details of their business. The nature of potato marketing in this State is perhaps best demonstrated by 26 growers who used 20 different outlets to sell their 1950 crop. Three acreage groups have been drawn up for this report: 1 to 6, 8 to 13, and 25 to 100 acres. Each acreage group had distinctive marketing practices, but some methods were common to all. Direct selling was the rule with growers of the smallest acreages, who sold to local or nearby outlets, such as retail stores and their own farm stand, or peddled direct to consumers. In the 8- to 13-acreage group, direct selling was also important, but some different and larger outlets, such as hotels and restaurants, institutions, potato chip manufacturers, peddling, and city wholesalers, were used in addition to retail stores; the hauls were also somewhat longer. The 25- to 100-acreage group used 13 different outlets: country shippers, sales for price support, chip manufacturers, retail stores, chain store buyers, city wholesalers, and institutions. Direct selling was important, and long hauls (seldom over 150 miles) were common.

Storage operations were an essential feature of the marketing practices of the large growers. The principal variety was Katahdin, and late production accounted for over 80 percent of the total reported. Fifty percent of the 1950 crop was sold by December 1, including almost

all the early crop and part of the late. Of the potatoes stored beyond December 1, the largest volume was marketed during December, January, and February. Some stocks remained in storage until May.

**Pricing Eggs on the Boston Market.** (A. A. Brown, R. W. Brundage, and Alden Manchester.) The inadequacies of the system of pricing "nearby" eggs in Boston are brought out in the current study. In 1950, receipts of nearby (New England) eggs at Boston amounted to 14 percent of the receipts of the total production in the area, and only 12 percent were reported as sales by the Boston Herald. Slightly less than 2 percent of the quantity produced in the area served, therefore, as the basis for pricing.

In addition to the relatively small basis available for pricing purposes, no report was made on 16 market days. Moreover, the report showed no information available on four days and indicated three days on which only bids and offers were reported.

Prices for "nearby" eggs at Boston were closely related to those paid for brown eggs of comparable size and quality at New York City. The relationship was somewhat erratic on a day to day basis, indicating shortcomings in market information or possible inadequacies in the buying and selling arrangements between the two markets. Seasonally, however, prices in the two markets revealed a consistency with this qualification that when New England supplies were short to ample (January to July), Boston exceeded New York by  $1\frac{1}{2}$  to 2 cents, but when New England supplies were abundant (September to December), the New York margin over Boston was three to four cents. The variation in spreads was due to differences in grading practice in the two markets. Extra large were sorted from large in Boston; in New York these two sizes were not separated. The New York market has a very marked influence on price-making in Boston. The shortcomings of the New York market, however, as well as its good points, extend outward.

Better price-making in Boston is dependent, in the first instance, on improved market statistics. The data need to be related to present market organization and marketing arrangements.

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## DEPARTMENT OF AGRICULTURAL ENGINEERING

H. N. Stapleton in Charge

**Investigations on Mechanizing Cranberry Production.** (Earle F. Cox and F. B. Chandler.) A hydraulic sanding mechanism has been designed to replace wheelbarrow and hand labor for distributing sand on the cranberry bogs. With this mechanism, sand is introduced into an open jet which discharges into a Venturi section from which a mixture of sand and water (20 percent by volume) is carried through 340 feet of plastic pipe (3-inch inside diameter) out to the particular cranberry section to be sanded. After the sand is deposited, the water returns through the present drainage ditches. Operation has been successful with a pressure of 100 pounds per square inch at the jet.

A laboratory apparatus has been designed for testing spray nozzles. Tests have been run to determine the particle size and distribution of particle size from various nozzles. When a satisfactory nozzle is found, it will be used with the sprayer developed for the Allis Chalmers Model G tractor modified for use on cranberry bogs, mentioned in last year's report.

**Cranberry Harvesting and Packaging Investigations.** (Earle F. Cox and F. B. Chandler.) Bulk storage of cranberries has been investigated during the past year. Berries were placed in bins to a depth of 5 feet and stored wet or dry; a curing fan was employed. The keeping quality of berries at various levels within the bin differed very little; the berries stored dry kept better than those stored wet.

At the time of harvest, the following practices were investigated: leaving berries out overnight to cool, refrigerating for one to three days, fan cooling, hand and machine separating. After the tests, all berries were stored in the same screen house. Berries that were least disturbed during post-harvest handling kept best.

Tests were also conducted to determine (1) what percentage of berries saved by the separating machine could be obtained from the first two bounce boards and (2) the keeping quality of berries from the various bounce boards. Almost 75 percent of the sound berries were obtained from the first two bounce boards; moreover, these berries were far superior in keeping quality than berries from the third and fourth bounce boards. Results indicated that sufficient berries could be obtained from the first two bounce boards to supply the fresh fruit market.

**Investigations to Improve Tobacco Curing.** (H. N. Stapleton and Earle F. Cox.) This project has been a cooperative one with tobacco farmers. In two barns, installations were made with no auxiliary heat provided. Fans were run continuously, and a damper was provided to exhaust air or recirculate air. A good cure was reported in all parts of the barn although the cure did not seem superior to that in other barns where no fan was used. In the second barn, serious spoilage was reported in the second tier of tobacco. The two top tiers were well cured.

In a third barn where only natural air was employed, a good cure was reported. The fan was run almost continuously on recirculation, and the barn doors were never opened during the curing season.

A fourth barn had an indirect fired oil burner with a rated capacity of 8.9 gallons per hour. The burner was used for a short period; then fans to provide recirculation or exhausting of air completed the cure, and the burner, in the meantime, was started in a second barn. Foreign material in the nozzle reduced oil burner capacity to 5 gallons per hour in the first shed, where the third tier of tobacco was partially spoiled, and the fourth tier completely spoiled. In the second shed, the burner capacity was increased to 7 gallons per hour by cleaning the nozzle. Here, the cure was satisfactory even though the outside temperature was lower than the temperature during the time the tobacco in the first shed was being cured.

A Foxboro 24-point instrument recorded dry bulb, leaf, and dew point temperatures at each of eight different points within the shed. The leaf



temperatures were almost the same as the dry bulb temperature, but there was no consistency in their relationships.

A Foxboro 6-point instrument recorded dry bulb temperature in a second shed at six different points. The temperature varied as much as 15 degrees. Heat was introduced at one central point, and fans recirculated or exhausted air. Temperatures could be maintained very uniform throughout the shed when heat was not being run.

**Improvement of Poultry House Ventilation.** (H. N. Stapleton and Earle F. Cox.) An automatic system of ventilation was installed and used from February 1 until the end of the season. This system was used with a damper motor to give continuous exhausting of air from the house above a set thermostat temperature. Below this thermostat temperature the air was exhausted a set amount during a 10-minute cycle. For this test the set amount was 2 minutes during the 10-minute cycle. The system was satisfactory in performance. As a check against the automatic system, other exhaust fans were run intermittently according to the operator's judgment. This was not as satisfactory as the automatic system.

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## DEPARTMENT OF AGRONOMY

W. G. Colby in Charge

**Preparation of Tobacco Seedbed Soil.** (C. V. Kightlinger.) Several recommendations may be made to improve the methods of preparing tobacco seedbeds:

1. Old seedbeds should be destroyed as soon as possible after tobacco has been transplanted and restocked.
2. Frequent harrowing of the soil and early disposal of unused plants by killing with formaldehyde or by hoeing out before the seedbed is plowed and harrowed will reduce the supply of possible disease-causing inoculum.
3. The soil should be harrowed frequently throughout the summer.
4. In the fall the soil should be worked well, the seedbeds shaped, the soil fertilized and sterilized in this order.
5. Any sterilization method that is effective may be used. With steam sterilization, it is preferable to treat the soil in the fall because it may be difficult in the spring to keep the soil moistened sufficiently for plants to grow well. With chloropicrin or methyl bromide sterilization, the soil should be treated in the fall while its temperature is 60°F or higher, otherwise poor sterilization will result.
6. Soil should be well leveled and smoothed before seeding. If prepared for seeding in the spring, it should be worked to a depth of not more than 3 to 4 inches to keep unsterilized soil and viable weed seed from coming to the surface of the seedbed. Soil capillarity is more quickly re-established in this way than it would be with deeper cultivation because it prevents the formation of deep pockets or surface hollows.

**New Uses for an Old but Little Known Grass — Field Brome.** (William G. Colby and Mack Drake.) The need on vegetable land for a cover crop that does not become a weed hazard by reseeding itself if sown in late summer or early fall has focused attention on a winter annual similar to winter wheat or winter rye — Field Brome Grass (*Bromus Arvensis*). When seeded September 1, 1949, it produced 2600 pounds of roots (dry weight) per acre, whereas winter rye produced 1440 pounds. Nutritious and palatable, when fertilized adequately, it can be used for pasturing all types of livestock, including poultry, in late fall until freezing weather sets in. Heavy grazing or ranging will not seriously injure the sod.

In addition to producing forage in late fall and early spring, field brome is a very successful smother crop for many undesirable grasses, such as Kentucky blue grass, red top, bent grass, and witch or quack grass — a feature that makes it extremely useful in grassland systems of farming where intertilled crops are not included in the rotation.

This grass is a heavy consumer of nitrogen. Plantings in 1950 made on an old heavy bluegrass sod were fertilized with 1000 pounds per acre of a 5-10-10 fertilizer. Two top-dressings of ammonium nitrate were made during the fall and one before grazing started in the spring. About 40 pounds of elemental nitrogen were applied each time. As a cover crop, Field Brome should have supplemental nitrogen added, not only for growth but also for facilitating the breakdown of tough, heavy sod at plowing time.

**Farm Fish Ponds.** (Karol J. Kucinski.) An experimental fish pond was built in the valley of an orchard watershed of about 60 acres drainage to determine whether the powerful insecticides and fungicides that drain from the orchard would have any poisonous effects on fish in the farm fish pond. It was found that the toxic chemicals are rendered harmless or are immobilized by the soil colloids where they are applied and do not reach the pond waters in their original harmful state.

**Evaluation of Additions of Sodium Nitrate and Ammonium Sulphate Applied in Late Summer Preceding Spring Planting of Tobacco.** (Walter S. Eisenmenger and Karol J. Kucinski.) It has been a common experience for tobacco growers to obtain an inferior tobacco crop where they have plowed under sods of grasses, clover, or fields of corn stubble and then planted tobacco. This inferior crop may be due to excessive slowly decomposing fibrous tissue, or possibly such crops may invite nematodes during their growing period because nematodes seem to prefer grasses as their hosts. When much lignin is present, and plants are grown on the area, application of nitrogen overcomes, to a degree, the difficulty of malnutrition for the succeeding crop. Tests have indicated that it would be desirable to apply 50-100 pounds of nitrogen per acre when plowing under grass sod in the early spring if the land is to be used for tobacco.

**Irrigation Studies and Management of Irrigated Soils.** (Karol J. Kucinski.) Although the idea of irrigation is not new in this State, since there has been a limited use of permanent overhead irrigation on small intensively cultivated areas for many years, much interest has been

shown recently in supplemental irrigation for a wide variety of crops. Especially is this true during drought seasons. Part of this newly aroused interest has resulted from the advent of lightweight, quick-coupling pipe using revolving sprinklers or perforations that are adaptable even on rolling ground.

It is felt that in many cases the increase in crop yields, the insurance against crop failures, and improvement in quality of the product will more than justify the original cost of installation and subsequent maintenance. However, there is need for much more information concerning the proper soil and crop management practices where supplemental irrigation is employed and also on various engineering phases of the problem.

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## DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

**A Study of the Mineral Elements of Cows' Milk.** (J. G. Archibald.) The work with molybdenum has been completed. A manuscript entitled "Molybdenum in Cows' Milk" has been submitted for publication in the Journal of Dairy Science. The following is quoted from the summary of that paper:

"Molybdenum appears to be a natural constituent of cows' milk, the amount varying in different breeds and individuals but of the general order of 40 to 70 micrograms per liter of whole milk.

Feeding 500 micrograms daily of ammonium molybdate to eight cows for periods of two months increased the average amount of molybdenum in their milk about fivefold.

The level of molybdenum in these milks was higher than that of manganese and much higher than the level of cobalt. The response to feeding a supplement of the element, as indicated by increased levels in the milk, was greater than for any other trace element studied thus far.

Milk samples from control cows milked directly into glass showed levels of molybdenum similar to those obtained via the milking machine, thus eliminating the possibility that any of the molybdenum in these control milks was due to metallic contamination.

Analysis of composite samples of cream and skim milk showed that most of the molybdenum in 'control' milks or in those from cows receiving a molybdenum supplement was concentrated in the cream fraction."

**A Study of Quality in Roughage: Composition, Palatability, and Nutritive Value of Hays as Affected by Curing, Harvesting, and Storing Procedures.** (J. G. Archibald, M. L. Blaisdell, E. Cox, and H. N. Stapleton.) Studies of the chemical composition of a large number of hays grown on the University farm and on farms in different parts of the state reveal that:

The weather during the growing season did not have any substantial effect on the composition of grass at cutting time.

The principal loss during the curing of hay was in carotene; exposure to bright sunlight was more destructive of carotene than was a moderate



amount of rain. Protein was substantially unaffected by the curing process regardless of weather.

Hays in which the curing process was completed by barn-drying were significantly higher in carotene at time of storage than were those completely cured in the field, but this advantage had disappeared almost entirely by the time the hays were fed out.

Changes in composition during storage were considerably greater than those which took place in the field after cutting. Most of these changes took place in the first month of storage, a large part of them during the first week.

Losses of nitrogen-free extract, sugar, and carotene during storage were closely related to moisture content of the hay at time of storage.

Feeding trials for milk production with barn-cured and field-cured hay gave identical results.

It is our opinion that the advantages of barn-curing of hay are to be found in shortening of the hay-making operation and in saving hay from spoilage by weathering rather than in greater nutritive value of the product as fed out.

Barn-drying is a useful adjunct in any system of storing forage, but one should not expect miracles from it. Good hay can be spoiled very easily by improper or inadequate drier installations.

In view of the losses of carotene in storage regardless of method of drying, it is recommended that farmers assure the carotene supply for their animals by storing as much as possible of their first cutting hay in the form of grass silage.

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## DEPARTMENT OF BACTERIOLOGY

Ralph L. France in Charge

**Differential Studies of *Pseudomonas* Species.** (James E. Fuller and Robert E. Canning.) This study was undertaken cooperatively with the Mastitis Laboratory to obtain information that would aid in the detection and identification of strains of the genus *Pseudomonas* that are found in the testing of dairy herds for mastitis. The study included two phases: (1) an investigation of media for detection and (2) a study of the water-soluble pigments produced by the organisms as a possible basis for species identification. Colonies appearing on blood-agar plates could be verified as *Pseudomonas* species by pigment production when transferred to a medium containing asparagine, dipotassium phosphate, and magnesium sulfate. Koser's sodium-citrate medium was also usable, but less satisfactory than the asparagine medium. Standard differential tests indicated that all the cultures studied were *Pseudomonas aeruginosa*, but the use of pigment production as a basis for quick identification was not dependable.

**Studies on Plate Counts of Bacteria.** (James E. Fuller and William C. Squires.) The clumping of bacteria has always been a problem in making plate counts of bacteria because different clumps contain widely varying numbers of bacteria, yet each clump is likely to produce only one countable colony on a plate. An effort was made to break up bac-

terial clumps by reduction of surface tension with surface-active agents and fatty substances, and by mechanical separation of clumps with high-speed mixing procedures. None of these methods was effective because the separated bacteria exhibited a definite tendency to reclump rapidly, which indicated the probability that clumping is a natural phase of bacterial behavior for the mutual benefit derived from close association of cells of a species. If this is true, the effort to break up clumps does not appear to be logical.

**Bacteriological Study of Sour Cream Made by the Supplee Method.** (James E. Fuller and Robert W. Bibeau.) This study was made in cooperation with the Department of Dairy Industry of the University to obtain information regarding the necessity for agitation during the souring period and the survival of bacteria introduced into the cream during agitation. Results indicated that agitation was not necessary but could be objectionable because of the possibility of introducing contaminating bacteria during the process. Seven species of commonly-occurring bacteria that might easily gain entrance to the souring cream were found not only to survive but to multiply in the product. Bacteriological examination of some commercially-soured cream samples indicated that care and cleanliness had been exercised in their preparation.

**Bacteriological Studies with Hens' Eggs.** (James E. Fuller and Walter C. Flanders.) This study was made to secure information desired by the Department of Poultry Husbandry. The first part of the study concerned the isolation and identification of bacteria from the surface of eggs from a disease-free flock of hens. These organisms included fecal and skin flora and those species common to dust and soil. No pathogenic bacteria were found. The egg contents were nearly free from bacteria of any type. Experiments were carried on to investigate the penetration into the egg contents by the bacteria occurring naturally on the shells. There was little penetration into eggs stored dry, even at room temperature. Eggs tested were in three categories: not cleaned, washed, and sanded. When eggs were placed in sterile nutrient broth and stored at room temperature, the bacteria present on the shells grew in the broth and readily penetrated through the shell into the egg contents. Washing the eggs to clean them increased shell porosity and facilitated the penetration by bacteria; sanding permitted an even greater penetration by bacteria. A quaternary ammonium solution, 200 parts per million concentration, employed to wash one lot of eggs was effective in preserving the sterility of the egg contents. This procedure would not be legal now, but it is worthy of further investigation, and it should be possible to overcome objections so that legal restrictions could be removed.

**Bactericidal Action of Ozone.** (John M. Dickerman and Arthur O. Castraberti.) Ozone has been employed on a considerable scale in Europe and South America as a sterilizing agent for municipal water supplies. The method has not found favor in the United States because the equipment has been unwieldy and expensive to operate. Recently improved equipment that can be operated more economically has been developed;

an investigation of the bactericidal efficiency of ozone was then undertaken. The main objective was the destruction of microbic life in water. Secondary objectives were the removal of tastes, odors, color, and organic material. An ozone residual of 1 to 2 parts per million was found to be effective against microbic life in the absence of organic matter in the water. When organic matter is present, it combines with and inactivates ozone, requiring a greater ozone residual. Ozone was found to be more effective than chlorine for the sterilization of water, when the two were compared in equal concentrations.

**An Antibacterial Substance in Cabbage Extract.** (John M. Dickerman and Samuel Liberman.) A study was made of a number of vegetable juices to determine the possible presence of substances that would be antagonistic to bacterial growth. One such substance, found in aqueous extracts of Danish Ball Head cabbage, inhibited the growth of groups of pyogenic, intestinal, and sporulating types of bacteria. A study of the chemical structure of the substance, by means of paper-chromatographic procedure, indicated that it had strong reducing properties and was probably carbohydrate in nature.

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## DEPARTMENT OF BOTANY

Theodore T. Kozlowski in Charge

**Determination of Fungous and Bacterial Pathogens in Commercial Propagating Stock of Carnations.** (R. W. Ames.) Culturing of carnation cuttings to secure disease-free stock has been practiced in commercial concerns with apparently satisfactory results. Studies were made to determine the actual value of such a technique in detecting and eliminating infection and to compare the advantage of this method in culturing with that of the current practical method of careful selection and sound cultural practice.

The presence or absence of *Fusarium* was determined in 100 cuttings from apparently healthy plants of two varieties, Northland and Virginia Hercules. In Northland, the percentage of cuttings infected varied from 2.5 to 18.0, whereas in Virginia Hercules the percentage varied from 5.3 to 11.2. Suitable plots of rooted plants of both cultured and uncultured cuttings will be grown for flowering to determine the feasibility and practicability of this technique.

**Improved Methods of Control of Clubroot of Crucifers and Other Soilborne Diseases of Plants.** (W. L. Doran.) Growth of cabbage plants was improved by the addition of ground limestone with mercurous chloride to soils both infested and uninfested with *Plasmodiophora brassicae*, but growth of plants in infested soils showed greater improvement. All applications of mercurous chloride to the soil were made through commercial fertilizers as carriers. Effects of ground limestone and mercurous chloride on clubroot and growth of plants in 11 different soils inoculated with *Plasmodiophora brassicae* are being compared.



Technical chlorobromopropene (25 percent by weight, active) 0.5 gm. per square foot of soil controlled damping-off of beet, cabbage, and tomato seedlings but did not control clubroot. Vancide 51 controlled damping-off of beet, cucumber, and lettuce seedlings at the rate of 0.6 cc. per square foot immediately after seeding.

**Tomato Leaf Mold Caused by the Fungus *Cladosporium fulvum* Cke. (E. F. Guba.)** Since the previous report, two further generations of our three new hybrid red tomatoes have been selected for resistance to *Cladosporium* and desirable fruiting type, and effort has been directed towards producing types with larger fruit than Improved Bay State. The No. 4 tomato has much larger fruit than Improved Bay State, and growers regard it favorably. Hybrids Nos. 2 and 3 are immune to *Cladosporium*, deriving this immunity from *Lycopersicon peruvianum* (L.) Mill. These are still being selected for further improvement and have been crossed with improved Bay State in an effort to combine immunity to all forms of leaf mold with desirable commercial type.

Introductions of our leaf mold resistant tomatoes have contributed to significant savings and increased earnings to growers. Tucker (Missouri) combined resistance to *Cladosporium* in Improved Bay State with resistance to Fusarium wilt. Budzien (Wisconsin) has developed a pink tomato for Milwaukee with resistance to *Cladosporium* derived from Improved Bay State.

**Effect of Fluorescent Sun Lamp on Plants.** (L. H. Jones and E. A. Snow.) At a distance of 30 inches and under continuous illumination, various plants were severely injured by the rays of a 20-watt fluorescent, ultraviolet light bulb. Temperatures of the soil and air under the bulb were not raised by the cold light. When window glass or celluloid was inserted between the light and the plants, no injury resulted; however, quartz glass allowed the lethal rays to pass through.

**Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment.** (W. L. Doran.) Work was continued on the best methods of using fungicides, especially Phygon XL (50 percent 2,3-dichloro-1,4-naphthoquinone) quinone) in the treatment of cuttings. The fungicide was applied to cuttings by either the powder-dip or the solution-immersion method. In some cases, such treatments of cuttings with fungicides were used in combination with root-inducing substances. In other cases, the treatments were used alone.

Phygon XL is giving better results with cuttings of most species than other fungicides similarly used. Phygon XL, 0.3 gm. per liter for 24 hours, used with indolebutyric acid in solution, improved rooting of softwood cuttings of *Cornus florida*, *Clethra barbinervis*, and *Rhododendron calendulaceum*, and rooting of leaf-bud cuttings of *Rhododendron catawbiense* more than did indolebutyric acid used alone.

Phygon XL, used in this way, also improved the rooting of cuttings of *Rhododendron catawbiense* when no indolebutyric acid was applied.

Rooting of fall and winter cuttings of conifers (an arborvitae, a juniper, and a fir) was more improved by powder-dip treatment with Phygon XL, Phygon XL (talc 1:1 and Phygon XL), Hormodin No. 3 (1:2) used with indolebutyric acid or a-naphthaleneacetic acid than by the root-inducing substances used alone and applied by the solution-immersion method.

It was found that cuttings of *Tsuga canadensis* rooted in larger percentages if made from wood in its first year than if made from wood in its second year. Percentages of cuttings that rooted were markedly increased by treatment of cuttings with indolebutyric acid and with a-naphthaleneacetic acid. Cuttings of hemlock were successfully taken from many trees between mid-August and late January. Percentages of cuttings of hemlock that rooted were increased by their powder-dip treatment with Phygon XL alone or variously diluted, such treatments supplementing solution-immersion treatments with root inducing substances.

**Investigations of Fungicides That Promise Value in Apple Disease Control.** (E. F. Guba.) Weather conditions at Waltham in 1950 were unfavorable for apple scab. The rainfall for April was 2.29; May, 1.31; June, 1.43; July, 1.53; August, 4.55; and September, 1.67 inches; with the total rainfall for the period being considerably below normal. To compare the effect of post-infection applications of fungicides on scab control, the following materials were tested: Koppers Flotation Sulfur Paste, 12 lb.; Phygon XL and Epsom Salt,  $\frac{1}{2}$  and  $\frac{1}{4}$  lbs.; Puratized Agricultural Spray, 1 pint; and Puratized Apple Spray, 1 pint. Applications were as follows: Prepink, May 5<sup>1</sup>; Pink, May 12<sup>1</sup>; Calyx, May 22<sup>1</sup>; 1st Cover, May 29<sup>2</sup>; 2d Cover, June 2<sup>3</sup>; 3d Cover, June 7<sup>2</sup>; 4th Cover, June 16<sup>2</sup>; 5th Cover, July 7<sup>2</sup>.

Insecticide (DDT and lead arsenate) with Phygon-Epsom Salt caused 9 to 10 percent russeted Delicious apples; insecticide with Flotation Sulfur Paste, 5 to 8 percent; insecticide with phenylmercuri fungicides (Puratized Agricultural Spray and Puratized Apple Spray), none. More or less Phygon foliage chlorosis was noted on McIntosh, Delicious, and Baldwin foliage. Kolofog and Phygon combined (3 lb. and  $\frac{1}{4}$  lb. did not produce apparent foliage chlorosis. Yellow foliage and defoliation occurred on unirrigated Baldwin and Delicious trees sprayed with phenylmercuri fungicides.

Irrigation greatly increased fruit weight and volume. Stippen or Baldwin spot was most prevalent at harvest in fruit from irrigated trees but did not increase after four months of storage.

Combining foliage chemical nutrients with insecticides and fungicides in the spray tank is being commercially practiced. In cooperation with W. D. Weeks and W. D. Whitcomb, comparisons are being made of mixtures containing sulfur, ferbam, lead arsenate, DDT 50 percent wettable, NuGreen, Epsom Salt, Borax, TEPP and Dimite on McIntosh, Rhode Island Greening, Delicious, and Northern Spy. Mixtures without sulfur or ferbam are not fungicidal according to laboratory studies.

<sup>1</sup> Fungicide only. <sup>2</sup> Insecticide only. <sup>3</sup> Insecticide and Fungicide. Insecticide used was lead arsenate 2 lb., 50 percent DDT wettable 2 lb. to 100 gallons of water.

**Resistance to *Fusarium dianthi*, the Cause of a Serious Carnation Wilt Disease.** (E. F. Guba.) Since the previous report, numerous seedlings of selfs of John Briry and Eleanor and crosses of these two commercial varieties are being grown. Cuttings are being propagated and inoculated with *Fusarium* to identify susceptible lines. Susceptibility and immunity have appeared, and it is still too early to appraise commercial possibilities. It is planned to self the seedlings showing resistance to the *Fusarium* fungus, to repeat the routine of growing, propagating, and inoculating until pure lines for resistance have been obtained, and to backcross resistant seedlings to resistant parents in an effort to combine resistance with desirable commercial type.

Three of the investigator's earlier seedlings (Regal Pink, Waltham Pink, and Mrs. E. F. Guba) released to the trade are resistant to *Fusarium* wilt and are being widely disseminated. Mrs. E. F. Guba, the most unusual and outstanding of the three varieties, received an Award of Merit at the 1950 New England Carnation Growers Variety Day at Tewksbury, Massachusetts. It scored 90 points, the highest of any variety, at the New York Florists' Club Carnation Night in February, 1951. It also won a Certificate of Merit and scored 91 points at the American Carnation Society exhibition in Dayton, Ohio, in March, 1951, and missed the "Best Variety in the Show" by one point.

**Top Soil Applications of Chemicals for the Control of Carnation Wilt Diseases.** (E. F. Guba and R. W. Ames.) Chemicals showing promise as soil disinfestants in fundamental laboratory pilot tests were applied to soil in a mixture with sand at regular intervals. Rhizoctonia stem rot control, plant tolerance, and yield were considered in evaluating treatments.

Preference was shown in every respect by New Improved Ceresan 0.78 oz., Fermate 3.10 oz., and Semesan 3.10 oz. per 100 sq. ft. of growing bed, per application. Loss from stem rot in beds not treated with chemicals was much greater; for example, a 20.3 percent loss was reduced to 3.6 percent by New Improved Ceresan; 4.2 percent by Fermate and 5.7 percent by Semesan. However, in practice this loss can be largely avoided by shallow planting and sound cultural practices. Phenylmercuri acetate in a dilution twice that recommended for plant protectant spraying, 1 pint per square foot, at monthly intervals also gave some control of Rhizoctonia stem rot. In other tests no control of *Fusarium* and *Phytophthora* wilts (both systemic diseases) could be shown by chemical soil treatments.

In general, soil application of fungicides in beds planted to carnations as a method of controlling the systemic wilt diseases is not considered advisable; growers have been benefited measurably by heeding this advice. The general failure to control wilt diseases by soil applications of chemicals has encouraged growers to consider judicious selection of propagating stock, laboratory culture of cuttings to eliminate infection, and soil steaming.

**Tobacco Frenching.** (L. H. Jones.) Previous work in this laboratory has made it possible to induce frenching of tobacco at will. The two most important conditions are the presence of the frenching factor in the soil and relatively high soil temperature. No symptoms of frenching have ever appeared when the soil temperature was 70°F. or lower. Lowering a soil temperature from 95°F. to 70°F. causes each new



leaf on a frenched plant to appear less frenched to the point where normal leaves are developed. Tomato (John Baer) and the smooth-leaved tobacco, *Nicotiana glauca* Graham, developed abnormalities when exposed to the frenching factor at a high soil temperature. Pepper (California Wonder) which is in the same family as tobacco and tomato, has not shown any susceptibility to the frenching factor.

Although the exact nature of the cause of frenching is not known, evidence points to a soil-borne organism which under conditions of high soil temperature affects some basic nutrient supply or creates a toxin that is absorbed by the plant. This frenching factor has been recently found in soils on which tobacco has probably never been grown. It is the opinion of this investigator that the frenching factor will be found, in particular, in soils that are quite moist even in protracted drought periods. Samples used during the past year have given 100 percent positive tests to support this opinion. By increasing the amounts of applied hydrated lime to a soil with an original pH of 5.5, the acidity of the soil was decreased to a pH of 7.4. Plants at a soil temperature of 95°F. within this range of pH values frenched earlier, and symptoms were more intense where lime was applied. However, with larger amounts of lime and an increase in pH, there was a slight lag at pH 7.9. It took 46 days for frenching to appear at a pH of 8.07, but only an average of 16 days to appear in the non-limed soil. Further increase in the amount of lime raised the pH value to 8.32, and during the 75-day period of this experiment no frenching symptoms appeared.

**Histology of Frenched Tobacco Leaves.** (L. H. Jones, E. C. Putala, and L. H. Weinstein.) Very young leaves of tobacco from normal, moderately frenched, severely frenched, and nitrogen deficient plants were prepared to study tissues, cell size, and nucleus size. From this study the preliminary results indicate a marked change not only in the gross morphology of leaves in a frenched plant but also in the cells and tissues of the leaf.

**Availability of Soil Moisture for Active Absorption in Drying Soil.** (T. T. Kozlowski and T. J. Army.) Whether or not water is equally available to plants in drying soil from field capacity to wilting percentage has not yet been confirmed. Two New England soils of varying textural grade, Merrimac Fine Sandy Loam and Suffield Silt, were used in an investigation to study the effect of soil moisture content on active absorption as measured by exudation from detopped plants. Experiments were performed on tomato (*Lycopersicon esculentum* Mill.), tobacco (*Nicotiana tabacum* L.), corn (*Zea mays* L. var. *identata*), and bean (*Phaseolus vulgaris* L.).

A total of approximately 60 percent of soil moisture in the range from wilting percentage to moisture equivalent appeared to be a minimum value which was not available for active absorption. Further evidence indicated that much greater forces for water intake are developed in tops of plants than in their roots.

**Effects of Mineral Deficiencies on Active Absorption by Plants.** (T. T. Kozlowski and A. J. Poivan.) This investigation was undertaken to determine effects of mineral deficiencies on active water absorption as shown by diurnal fluctuations in exudation from detopped plants and thereby to ascertain whether a direct relation exists between metabolism and active absorption.

All treated plants showed a diurnal variation in exudation rate, but this was least apparent for nitrogen-deficient and distilled water treatments. Total exudation for the duration of the experiment was greatest for the minus iron treatment, followed by complete solution, minus magnesium, minus phosphorus, distilled water, and minus nitrogen treatments. In plants grown in solutions lacking nitrogen and in the distilled water treatment, duration of exudation was short, complete cessation occurring two days after excision. The erratic variation and short duration of exudation cannot be attributed to differences in size of root systems. These effects appear to be attributable to varying metabolic rates conditioned by specific mineral deficiencies on active absorption by roots.

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## DEPARTMENT OF CHEMISTRY

Walter S. Ritchie in Charge

**Investigation of Agricultural Waste Products. II. The Chemical Composition of Certain Wild Plants, with Special Reference to the Content of Alpha Cellulose, Polyuronides, Gums, and Soluble Sugars.** (Emmett Bennett.) The plant kingdom is a storehouse of many chemical compounds present in varying amounts. Some may constitute approximately 50 percent of the dry matter of plants. This group, the structural carbohydrates in farm crops, has tremendous possibilities, but at present is of little economic importance. Depending upon its chemical composition, the same crop could be grown for industrial as well as for food purposes. An outlet for fibrous crops, damaged or otherwise, would be a decided economic advantage. With this in mind, approximately 30 economically unimportant plants have been analyzed for the content of total cellulose, alpha cellulose, furfural, and total soluble sugars. The results on a dry matter basis are as follows:

1. The content of cellulose ranged from approximately 20 to 50 percent; about one-third of the samples contained from 40 to 50 percent.
2. Approximately 60 to 70 percent of the total cellulose could be clarified as alpha cellulose. Twenty percent of the plants contained cellulose that consisted of over 70 percent alpha cellulose. The common smartweed, butterweed, and aster contained the highest percentage of this fraction.
3. The content of furfural varied from about 3 to 15 percent; about 25 percent of the plants contained over 10 percent. Poverty grass, jimson weed, butterweed, and witchgrass contained the highest percentage.
4. Soluble sugars ranged from about 3 to 15 percent; about 15 percent of the plants yielded over 10 percent. The stalks of the common milkweed, wild lettuce, members of the dock family, and the sedge plant contained the highest percentage.

**Relative Availability of Phosphorus Fertilizer Materials to Forage Crops.** (Mack Drake, Chemistry, and W. G. Colby, Agronomy.) Phosphorus is widely recognized as an essential element for plant and animal development. The long-lived legumes, alfalfa, and clover, valued for their high mineral and protein content, often fail because of inadequate supplies of available phosphorus in the soil. Desirable grasses such as smooth brome and orchard grass, which are grown in association with the legumes, remove large quantities of phosphorus. As contrasted to annual crops, these slower growing, longer lived perennial forage crops may remain on a given soil for 4 or 5 years. Thus the total amount of phosphorus required for 4 or 5 years of forage is large. If this total is supplied at planting in a soluble or available form as superphosphate, a large amount of the available phosphorus will become "fixed" as relatively insoluble (low availability) phosphates of iron and aluminum in the soil. On many soils the annual application of superphosphate as a top dressing may not be efficient. Furthermore the "world sulfur shortage" and increased demand for available phosphate fertilizers have reduced and will continue to reduce the supply of cheap available phosphorus for perennial forage crops in New England. Thus an efficient method for the use of large applications of slowly available phosphorus before planting is highly desirable. It is reasonable that for long lived, slower growing plants, such as the perennial forage crops, a form of phosphate such as finely ground raw rock phosphate that is less soluble, more slowly available, might be equal to or higher in over-all efficiency than the highly available, soluble forms such as superphosphate.

The present information on relative availability of phosphorus from finely ground raw rock phosphate and superphosphate (20 percent  $P_2O_5$ ) for forage crops is inadequate. Although superphosphate and rock phosphate have been compared in many field experiments, in many cases the treatments did not supply adequate quantities of nitrogen or potassium, or did not supply supply comparable amounts of sulfur.

A field experiment was laid out near Amherst in 1949 on a Merrimac fine sandy loam low in fertility. Alfalfa, timothy, and a ladino-smooth-brome grass combination were seeded across phosphate treatments. Three rates of finely ground raw rock phosphate (2000, 3000, and 4000 pounds per acre) were compared with two rates of 20 percent  $P_2O_5$  superphosphate. (1000 and 2000 pounds per acre). The combination treatment of 1000 pounds rock phosphate (with 50 pounds of sulfur) plus 500 pounds of superphosphate was included. Three rates of sulfur (0, 100, and 456 pounds per acre) were used with the 2000-pound rate of rock phosphate. Rock phosphate and sulfur were broadcast and disked into the surface 3 to 4 inches of soil. Pelleted superphosphate was applied in bands (7 inches apart and 3 inches deep) to minimize fixation. The yields from rock phosphate were expected to be relatively lower the first year; however, in 1949 the year of seeding was so dry that no yields were taken. By the second year when the first yields were taken, both rock and superphosphate supplied adequate phosphorus for plant growth. Phosphorus availability from the rock might not have compared so favorable in the first year. In 1951, two additional experiments of this type were laid out to check this and other points.



Results of the first harvest year, 1950, and the first cutting in 1951 were:

1. Ladino-clover-smooth-brome grass yields on 2000 pounds rock phosphate plus 100 pounds sulfur were equal to the yields in 1950 and were 7 percent greater in 1951 than on 1000 pounds superphosphate.

2. Timothy yielded 4 percent less in 1950, but 15 percent more in 1951 on 2000 pounds rock phosphate plus 456 pounds sulfur as compared to 1000 pounds superphosphate.

3. Alfalfa yields from 2000 pounds of rock were equal to 1000 pounds superphosphate, and were 6 percent greater for 4000 pounds rock phosphate plus 100 pounds of sulfur than for 2000 pounds superphosphate.

4. Phosphorus content of the forage on the above results was comparable.

5. On this soil there is an advantage in using a combination of rock-phosphate-sulfur and superphosphate. The combination treatment 500 pounds of superphosphate plus 1000 pounds rock phosphate with 50 pounds sulfur has produced greater yields of alfalfa, timothy, and ladino-brome than 1000 pounds of superphosphate.

**The Production of Holocellulose from Nonwoody Plant Tissue.** (Emmett Bennett.) Holocellulose prepared for subsequent quantitative determination of hemicelluloses contained at least two fractions. As judged by the production of furfural, the first fraction may be removed so easily that it is a handicap in quantitative procedures. A final fraction seems to be relatively stable to alternate chlorinations and sulfite treatments. A significant quantitative procedure should exclude the final fraction, which may amount to 30 percent of the total furfural.

**Influence of Processing, Distribution, and Storage on Loss of Ascorbic Acid in Milk.** (Arthur D. Holmes.) It is unfortunate that milk, so important in the human diet, loses so much of its original 20 to 25 mg. of reduced ascorbic acid per liter during processing, distribution, and storage. Reduced ascorbic acid may be destroyed considerably during the commercial distribution of milk, particularly when it stands in sunshine or bright light for any length of time on the consumer's doorstep. Notwithstanding all ideal conditions during processing and distribution, serious losses may still occur when milk is stored in the home refrigerator.

**Effect of Added Riboflavin on the Permanency of Ascorbic Acid in Raw Cow's Milk.** (Arthur D. Holmes.) Cow's milk, which contains about 10 times as much riboflavin as mare's milk, will lose 80 percent of its ascorbic acid during six days' storage in a refrigerator, whereas mare's milk will lose about 8 percent. To determine whether a larger amount of riboflavin will influence the stability of ascorbic acid, pasteurized cow's milk was fortified with U.S.P. riboflavin at the rate of 4 mg. and 8 mg., respectively. Seventeen series of milk samples prepared at intervals between September and March were stored from Monday to Friday in darkness at 10°C. and assayed at 25-hour intervals. During the 96-hour storage the unfortified milk, the milk fortified with 4 mg. and 8 mg. of riboflavin per liter lost 77, 73, and 69 percent of their reduced ascorbic

acid, respectively, indicating little if any change in the amount or rate of destruction of reduced ascorbic acid during storage in glass containers in darkness at 10°C.

**Reduced Ascorbic Acid Content of Milk at Different Stages of Processing.** (Arthur D. Holmes.) Variation of reduced ascorbic acid in different bottles of milk from the same lot of pasteurized milk was studied. Between August 1 and May 1 four samples from each of 17 lots of milk processed by the Dairy Industry Department in commercial dairy equipment were taken: the first sample represented the thoroughly mixed cold milk before heating in the pasteurizing vat; the second sample, hot milk, was taken from the vat immediately after pasteurization; the third sample came from the first 20 quarts of milk passed through the cooling and bottling equipment; and the fourth sample was the last milk through that system. The raw milk contained 18.6 mg. of reduced ascorbic acid per liter; after pasteurization the milk contained 17.1 mg., retaining over 92 percent of its original ascorbic acid. The 17 samples of the first milk through the pipe lines supplying the surface cooler and the bottle filler averaged 5.9 mg. of reduced ascorbic acid per liter; hence, this milk had lost over 65 percent of the ascorbic acid present after pasteurization. The last milk through the system contained over 15.6 mg. of reduced ascorbic acid per liter, retaining over 91 percent of the reduced ascorbic acid present after pasteurization. The atmospheric oxygen with which the heated milk came in contact during its passage through the equipment and the contact of the milk itself with the processing equipment were probably responsible for the excessive loss of reduced ascorbic acid. These values indicate one cause of the wide variation in reduced ascorbic acid of commercial retail milk.

**Changes in Vitamin Content Coincident with Different Stages and Rates of Maturity of Vegetables Used for Home Consumption.** (Arthur D. Holmes.) The constant demand for additional information on cultural procedures for production of a profitable yield of tomatoes of high food value has initiated a study of the influence of mulching on the mineral content of tomatoes. Twelve plots were used: three mulched plots and one control plot with two replicates of each. The mulches (horse manure, rye straw, and shredded sugar cane stalks) were applied three inches deep. During the 89-day growing season there were 680 hours of bright sunshine and 12 inches of rainfall; the temperature ranged from 41° to 100°F. All plots received a 5-8-7 commercial fertilizer at the rate of 2000 pounds per acre. On a dry basis, typical tomatoes contained the following amounts per 100 g.: calcium — 203 mg., 186 mg., 218 mg., and 193 mg.; magnesium — 268 mg., 254 mg., 276 mg., and 176 mg.; phosphorus — 530 mg., 716 mg., 564 mg., and 480 mg.; potassium — 3.0 g., 5.4 g., 3.5 g., and 4.0 g. for the control, manure, straw, and shredded cane stalks, respectively. Similar amounts of magnesium and nitrogen were found in the tomatoes from the experimental and control plots

THE CRANBERRY STATION  
EAST WAREHAM, MASS.  
H. J. Franklin in Charge

Prevalence of Cranberry Insects in the Season of 1950. (H. J. Franklin.)

<i>Insect</i>	<i>Degree of Abundance</i>
1. Bumblebees and honeybees.	Plentiful.
2. Gypsy moth	Hardly any found because of the spraying done with airplanes and helicopters by the gypsy moth authorities in Barnstable County in 1949 and in Plymouth County in 1950.
3. Blunt-nosed cranberry leafhoppers	Normal amounts in Plymouth County to rather heavy amounts in Barnstable County.
4. Fruitworm	About normal.
5. Black-headed fireworm	Rather less trouble than usual.
6. Yellow-headed fireworm	Little trouble.
7. Fire beetles	None found.
8. Spotted fireworms	None found.
9. Lady beetles	Very abundant.
10. Green spanworm	Rather more generally abundant than normal.
11. Brown spanworm	Little trouble.
12. False armyworms	Rather scarce.
13. Spotted and black cutworms and armyworms	Gave unusually little trouble after late holding of the winter flood and after grub flooding.
14. Girdlers	Gave very little trouble.
15. Spittle insect	Rather less troublesome than normal.
16. Root grub	About normal.
17. Cranberry weevil	This insect has been more troublesome than usual for the last two or three seasons.
18. Tipworm	Normal.
19. Blossom worm	Gave very little trouble.
20. Southern red mite	About normal.
21. Cranberry scale	This has been more widely troublesome the last two years than ever before in the history of the cranberry industry. It is also reported as troublesome in New Jersey.
22. Brown grasshoppers	Normal.
23. White grubs	Normal.
24. Grape <i>Anomala</i>	Normal.

**Frost Forecasts.** (H. J. Franklin.) Afternoon and evening forecasting of cranberry frosts was continued as in previous years. There were 176 subscribers to the special telephone service in 1950, and 177 in 1951. Frost warnings were also sent out by radio through Stations WBZ



(Boston), WNBH (New Bedford), and WOCB (West Yarmouth) in 1950, and WBZ, WOCB, and WBSM (New Bedford) in 1951. The warnings were prepared in cooperation with the Office of the United States Weather Bureau at Logan Airport.

**Fertilizer Requirements of Cranberry Plants.** (F. B. Chandler and W. G. Colby.) The use of liquid fertilizer in water solution greatly reduces the cost of application and gives a very satisfactory distribution. The nutrients are absorbed from the water quite readily, even when applied in the winter flood. As liquid fertilizer gives quite a uniform distribution, it should be used as a basic application. The locations requiring more fertilizer should be treated by hand with dry fertilizer.

**Cranberry Insect Control Methods.** (Anthony R. Briggs.) (Extracted from Master's Thesis.) During the 1950 insect season, research was conducted in an effort to discover which of the present-day cranberry insect control methods are the most efficient as related to control and cost. These methods are: the application of insecticidal dusts by ground machine, airplane, and helicopter, the application of insecticidal sprays by ground machine and airplane, and insect control by flooding the bogs with water. The insects considered were: the blunt-nosed leafhopper<sup>1</sup>, the blackheaded fireworm<sup>2</sup>, the green spanworm<sup>3</sup>, and the cranberry weevil<sup>4</sup>. The infestations were gauged by use of the cranberry insect net. The bogs were swept once prior to the treatment and twice after it, at two-day intervals — two and four days after control. Exceptions to this practice include some of the data gathered by the representatives of the A. D. Makepeace Company and a few cases in which the weather made the practice impossible. Data were collected every day that the weather permitted in the insect season.

The data on insect abundance, control, and reduction were subjected to statistical analysis. With the exception of some data derived from areas treated with pyrethrum, all bogs under observation were treated with DDT.

<sup>1</sup> *Scleroracus vaccinii* (V. D.). <sup>2</sup> *Rhopobota vacciniana* (Pack.). <sup>3</sup> *Itame sulphurea* (Pack.). <sup>4</sup> *Anthonomus musculus* (Say.).

Analysis of the data obtained by observations and experiments revealed:

1. There was no significant difference in the relative efficiency of control of green cranberry spanworms by the applications of ground dust, ground spray, plane dust, plane spray, or by flooding.

2. There was a significant difference in the relative efficiency of the six control methods in reducing infestations of cranberry weevil.

- a. Applications of spray by ground machine and by airplane are significantly more effective than other methods. No difference was found between these two methods.

- b. Ground dust applications and control by flooding were significantly more effective than the dust applications by plane and helicopter, but considerably less effective than the ground and plane-spray applications.

3. There was no significant difference between ground dust applications and plane dust applications in the control of blunt-nosed leafhoppers.

4. Helicopter dust applications reduced black-headed fireworm infestations more efficiently than airplane dust or airplane spray applications. No significant difference was found between the airplane dust and airplane spray applications in this connection.

5. There was a significant difference in the control of the four insects by applications of dust by airplane.

- a. The reduction of the blunt-nosed leafhopper and the green spanworm was significantly greater than the reduction of the weevil and black-headed fireworm by this method.
- b. It appeared to reduce with equal efficiency the infestations of the blunt-nosed leafhopper and the green spanworm; the same was true of infestations of the weevil and the black-headed fireworm.

6. The least expensive method of insect control is flooding. In order of increasing expense the methods are: flooding, plane spray, ground dust, plane dust, helicopter dust, and ground spray.

7. Applications of DDT dust (50 pounds per acre) were significantly more effective than applications of pyrethrum dust (75 lbs. per acre) in the control of the blunt-nosed leafhopper and the cranberry weevil.

- a. Although the number of green spanworms was small, the indications are that pyrethrum was not as effective as DDT.

**Control of Cranberry Bog Weeds.** (C. E. Cross.) Tests with the following weed-killers were carried out in sufficient numbers to warrant the drawing of certain conclusions: Stoddard Solvent, kerosene, alkanolamine and triethanolamine 2,4-D, triethanolamine 2,4,5-T, and copper sulfate solutions.

Stoddard Solvent can be sprayed safely on cranberry vines after October 1 at dosages up to 10 gallons per square rod. Maximum dose tests were made on several bogs in both Plymouth and Barnstable Counties, and in no case did Stoddard Solvent appear to injure the vines or reduce the crop the following year. Applications of 5 gallons or more per square rod killed all asters of all types, all summer-grass (*Agrostis*), poverty-grass (*Andropogon*), spike rush (*Juncus effusus*), canada rush (*J. canadensis*), wool-grass (*Scirpus*), and species of *Carex*; an 80 percent reduction in stands of loosestrife (*Lysimachia*), wild roses (*Rosa*), and small brambles (*Rubus*). Applications of 6 and 7 gallons per square rod killed 95 percent or more of the wild roses and small brambles. In preliminary tests, Stoddard Solvent applied in October at 7½ gallons per square rod reduced the population of saw briers (*Smilax*) by 50 percent and blackberries (*Rubus*) by 75 percent.

Post-harvest kerosene sprays are limited in value because their effect on cranberry vines is unpredictable — sometimes causing complete defoliation and loss of crop for one year, and at other times causing no apparent injury at all. In the fall of 1950, three series of experiments were made on widely separated bogs in Plymouth County with no vine injury resulting. Where kerosene was applied at 7½ and 10 gallons per square rod in October, at least 75 percent of the saw briers and over 60 percent of the blackberries were killed.

Mixed alkanolamine salts of 2,4-D regularly produced some volatilization vine burn when applied in 20 percent solutions to the tips of tall

weeds by the "wet glove" method. Even when the tall weeds were treated with these same solutions by gently brushing them with a swabbed hockey stick, it caused some injury to the cranberry vines beneath. Little or none of this form of injury occurs when the same methods are used to apply 20 percent solutions of the triethanolamine salt of 2,4-D. Both of the above salts have been used with some success in killing loosestrife, swamp loosestrife (*Decodon*), hardhack and meadow sweet (*Spiraea* spp.), 3-square grass (*Scirpus*), marsh St. John's-wort (*Hypericum*), and royal fern (*Osmunda*).

The results of spraying cranberry bog shores for the control of poison ivy, grape vines, saw briars, and bull briars were made more consistent by the addition of the triethanolamine salt of 2,4,5-T to the above salts of 2,4-D, in the proportion of 1 to 2.

Extensive preliminary tests were made during the last year to find inexpensive and selective weed-killers for the woody weeds of cranberry bog shores. To date, it appears safe and profitable to use amine salts of 2,4-D and 2,4,5-T for the control of poison ivy, wild grapes, chokeberry, wild cherry, morning glory, hardhack, meadow sweet, etc., on the shores of cranberry bogs and even in shore ditches, provided that no spray is allowed to drift onto adjacent cranberry vines. The best dilution appears to be 1 cupful of 60 percent concentrate (4 pounds 2,4-D or 3.3 pounds 2,4,5-T per gallon) in 4 gallons of water. Best results follow a spray of 250 gallons an acre in warm, dry, and sunny weather.

Several sprays made by dissolving copper sulfate in water were tested in August. The most satisfactory concentration was found to be 25 pounds in 100 gallons of water. This solution, sprayed at 250 to 300 gallons an acre, kills over 90 percent of the following weeds: warty panic-grass (*Panicum verrucosum*), fireweed (*Erechtites*), pitchforks (*Bidens*) and nutgrass (*Cyperus dentatus*). Early in August, this spray causes tiny specks to appear on some of the green berries. This trouble does not develop later in the month when the berries are partly colored. To be most effective in weed control, the spray should be applied on the annual weeds previously mentioned before they have produced mature seeds.

**Winter Protection.** (C. E. Cross.) A year ago, it was reported that rather concentrated sprays of wax on cranberry vines to prevent winter-killing increased the frost sensitivity of the treated vines the following spring. Tests of more dilute wax sprays in December, 1950, have shown no increase in frost susceptibility, but, because winterkilling conditions were not present during the mild and open winter of 1950 and 1951, it was not known whether or not these more dilute sprays offer sufficient protection.



## DEPARTMENT OF DAIRY INDUSTRY

D. J. Hankinson in Charge

**Sanitizing Agents for Dairy Use.** (W. S. Mueller.) From a sanitary standpoint, no other operation is more important in the production of high quality dairy products than the cleaning and sanitizing of dairy utensils and equipment. Hot water is essential for satisfactory washing, but unfortunately most dairy farms do not have an adequate supply of hot water for this purpose. Although steam is an excellent sanitizing agent, it is not as essential as hot water on the dairy farm because chemical sanitizing agents may be used in place of the steam. Both steam and chemicals have advantages and limitations as sanitizing agents for dairy use.

1. *Sanitization of Dairy Utensils by Heat.* (W. S. Mueller and W. T. Geenty.) Further studies were made to find a practical method of supplying hot water and steam for dairy farm cleaning and sanitization. The sanitization capacity of a small equipment unit consisting of a heater (available for burning natural or manufactured gas, stove oil, kerosene, or Diesel oil), a two-compartment wash sink, and a sterilizing cabinet was investigated. The efficiency of the heater, which will produce either hot water or steam, was also measured. It was found that the heater would produce hot water or steam within two minutes after lighting the burner. Milk cans or pails were effectively sanitized when steamed for three minutes within the steam chest or when placed for 30 seconds over the steam jet. The burner was found to be 70 percent efficient in fuel consumption (bottled gas), which by engineering standards is considered to be very good. When bottled gas was used, the cost of producing hot water and steam for cleaning and sanitizing the utensils on an average size dairy farm (20 cows) was calculated at 21 cents per day. Results of this study show that this type of steam sterilizer is both effective and efficient in its operation and could lend itself very satisfactorily to New England dairy farms.

2. *New Chemical Sanitizing Agents.* (W. S. Mueller.) The ideal chemical sanitizing agent for dairy use should be colorless, odorless, tasteless, stable, nontoxic to humans, noncorrosive, not adversely affected by organic matter or hard water, inexpensive, and should have bacteriostatic action as well as germicidal action. The dairy industry is now limited to two types of chemical sanitizing agents; namely, chlorine and quaternary ammonium compounds. Both of these chemicals have sufficient limitations to make it desirable to look for better sanitizing agents. Various resorcinol compounds, chlorinated phenols and chlorinated morpholinium compounds have been studied as possible sanitizing agents for dairy use. Although many of these products have excellent germicidal properties, they have not been perfected to the point where they can be recommended for replacing the chlorine or quaternary types of sanitizing agents.

In quaternary investigations it was found that as little as 5 to 10 p.p.m. of quaternary in the milk would significantly retard acid and curd formation in the manufacture of cottage cheese. Thus, dairy farmers and milk plant operators should use sanitizing procedures that will avoid contamination of the milk with inhibitory concentrations of quaternary.

## DEPARTMENT OF ECONOMICS

Philip L. Gamble in Charge

**Public Land Ownership in Rural Areas of Massachusetts.** (David Rozman.) With the growth of urban centers and the increase of city population over a period of years, there has been a considerable expansion of public land ownership in rural areas of Massachusetts at both the State and local levels, especially to satisfy the need for land, water supplies, recreational developments, highway systems, and other requirements of public convenience, health, and safety. Likewise, large areas of land have come into public ownership in the interest of conservation of natural resources with special consideration for the development of systematic forest culture.

The expansion of public ownership in rural areas has left its mark and is having a continuous effect on the rural communities and the agricultural land utilization of the State. Hence, the primary purpose of this study is to appraise this effect on the local population and on agriculture in general. The investigational work so far has been directed towards the determination of the extent and character of public land ownership by obtaining pertinent information from both State and local sources.

## DEPARTMENT OF ENTOMOLOGY

A. I. Bourne in Charge

**Insecticides Control European Corn Borer and Increase Yields.** (A. I. Bourne.) Methods for European Corn Borer control involve applications of sprays or dusts into the central whorl, emerging tassels, and young-forming ears at 5 to 7 day intervals during the hatching period to place the poison on the points where the young newly hatched larvae feed.

When  $1/3$  to  $1/2$  grown, the larvae burrow deeper in the stems or ears and become true "borers." Control measures to be effective must reach the young caterpillars in the early stages of their development. The rapid growth of the corn during the hatching season, varying dates of planting, and type of season combine to make proper timing difficult.

The adult moths, however, seldom are attracted to corn until it has reached a height of 10 to 12 inches to the base of the central whorl. Plantings, therefore, in which the corn has reached this state at the beginning of the hatching period or later plantings that will reach that height during the 3 to 4 week period of larval appearance should receive spray or dust application.

Experience has shown, however, that, in general, regardless of the growth stage of the corn the most accurate measure of timing the insecticidal treatments is to base them upon the first hatching of the egg masses in the field. Individual growers should learn to discover the egg masses in their own particular fields and to recognize the different stages of egg development to determine accurately when to begin their spray or dust schedule.

If treatments are delayed, the early appearing larvae will work deep into the stalks beyond the reach of later sprays and thus remain undisturbed for their total larvae life, lowering the vitality of the plant and reducing the size and quality of the ears.

These larvae also pass into pupation and furnish a sizable second brood. If only the late-appearing larvae escape treatment, they can cause little damage to the plant or ears and furnish few pupae for the later brood and delay its appearance. This prolongs the length of the "free period" between broods during which corn in this area requires no treatment.

Field experiments have shown that proper materials accurately timed will allow a very high percentage of borer-free corn, a larger percentage of the total yield being of marketable grade, and an actual increase in number of ears. Commercial growers are demonstrating this in their own fields. Field tests in Massachusetts in a season of moderately heavy abundance showed that 95 percent of the ears from treated plots were borer free and 94 percent of the total yield was of marketable grade. In the check plots, however, 64 percent of the yield was free from borers but only 55 percent of the total yield in the earliest pickings were of marketable grade and only 33 percent of the late picking were salable ears.

Many of the earlier materials used for borer control retained their effectiveness for only a 3- or 4-day period. To cover the hatching period a schedule of 4 applications at 5-day intervals was necessary. Field experiments at this station have shown that DDT and other newer insecticides give protection for a longer period and that a schedule of 3 applications at 7-day intervals will give adequate protection, eliminating completely the cost of one application.

The application of DDT, Parathion, and similar materials to corn involves so much risk from poison residue that corn so treated is not recommended to be fed to stock. The use of Ryania does not involve such a hazard.

The field experiments in 1950 involved studies of different formulations of Ryania alone and with the addition of activating agents in both spray and dust applications. Yield records showed 99 percent of the ears in the treated plots to be uninfested and 88 percent borer free ears in the checks. Even in the face of a light infestation following spring weather conditions unfavorable for corn borer moth activity, there was an increased yield of marketable ears per thousand plants over the untreated plots.

Records over a 5-year period of the yield on the same farm showed increased yields following borer control treatments.

Even in seasons of light infestation (1945 to 1950) there was a slight increase in yield following treatment, and in a season of moderate to heavy attack (1949) the differential was of significant proportions.

**No. 1 Insect Enemy of Apples Controlled by Methoxychlor.** (W. D. Whitcomb, W. J. Garland, and C. S. Hood.) As in several previous seasons, the plum curculio was the most destructive insect pest of apples in 1950 especially in eastern and central Massachusetts. At least, 90 percent of the apples on unsprayed trees were damaged, and in some commercial orchards where sprays were poorly made, incorrectly timed, or where ineffective materials were used, the injury reached 15 to 20 percent. Maximum activity took place June 1 to 13, 1950, when high temperatures stimulated feeding and oviposition by the overwintered



beetles and definitely corroborated the results of temperature studies in recent years. Under these conditions, the recommended insecticide formulation, lead arsenate-DDT, failed to give satisfactory protection under grower conditions and in the experimental tests permitted 11 to 14 percent of the apples to be stung. Grower criticism was strong, and the demand for better control was great.

Fortunately, preliminary experiments had shown much promise from methoxychlor, a newly formulated analog of DDT, and orchard tests confirmed the value of this insecticide for control of the curculio. Methoxychlor as a 50 percent wettable powder used alone at 3 pounds, or at 2 pounds in combination with 2 pounds of lead arsenate or with 2 pounds of 50 percent TDE (DDD), in 100 gallons, gave 99.32 to 99.60 percent protection in the experimental orchard tests. Although there was no significant difference among the formulations containing methoxychlor, the most practical and economical spray appeared to be the methoxychlor-lead arsenate combination. Several commercial orchardists who used this combination on a trial basis reported outstanding control of curculio and will use it extensively the following season. It will be officially recommended in the spray schedules for the coming season.

In experimental orchard tests, other insecticides gave better control than the treatments previously recommended. Combinations of 25 percent Aldrin wettable powder 2 pounds plus 50 percent DDT 1 pound, and 2 pounds of 15 percent parathion wettable powder plus  $\frac{3}{4}$  pound of charcoal as safener for McIntosh apple foliage, both gave 95 percent protection. Further studies of these and other similar insecticides should prove their value, and there is great promise for much better control of the plum curculio in the future.

**Chlorinated Hydrocarbon Insecticides Replace Corrosive Sublimate for Cabbage Maggot Control.** (W. D. Whitcomb, W. J. Garland, and C. S. Hood.) The cabbage maggot continues to be a major pest of crucifers, and growers of these crops frequently lose 5 to 20 percent of their plants in spite of treatment with insecticides. Much of this loss is due to failure to apply the treatments when the first eggs are laid by the cabbage maggot fly. Experiments have shown repeatedly that treatments applied within 48 hours of the time the first eggs are laid are more effective than later applications. Two applications of insecticides at an interval of 7 to 10 days are always more effective than one, and usually are necessary for successful control with dusts.

In 1950, at Waltham, cabbage maggot eggs were first found on May 4, and the treatments described below were applied the following day and, in most cases, repeated one week later. In the experimental plantings, 65 percent of the untreated cabbage was damaged by this insect. Under these conditions, the old standard treatment, corrosive sublimate, 1 ounce in 10 gallons of water, applied as a drench of  $\frac{1}{2}$  cupful per plant in two applications gave perfect protection, but one application permitted 3.3 percent injury. In a similar drench application made once, a 74 percent chlordane emulsion diluted at  $1\frac{1}{2}$  quarts per 100 gallons or 1 ounce in 1 gallon gave perfect control but may have caused some plant injury because 12 percent of the heads were below normal size.

The most effective dust applications were with 1.5 percent lindane and 3 percent Aldrin. Although 3 percent chlordane dust gave very good protection when used in two timely treatments, one application of this dust was the only treatment that failed to give satisfactory protection. Dusts are becoming more popular because of the ease of application, and following the satisfactory control obtained in these experiments they will be used in greater volume.

**Soil Insecticides Make Greenhouse Carnations and Roses Immune to Pests.** (W. D. Whitcomb and C. S. Hood.) Greenhouse florists have shown considerable interest in a practical method for controlling red spider and other pests by a soil treatment that is absorbed by the plants to make them immune. Experiments of this kind were started on both carnations and roses using two systemic organic phosphate formulations called E-20/58 and E-1059 (Systox). Preliminary tests soon showed that E-1059 was the more effective, and further studies with it were made.

On carnations a dosage of 1 pint per square foot of E-1059 diluted 1-16000 was unsatisfactory, but a dosage of 1 quart per square foot in two applications three weeks apart reduced the population of red spider mites to a minimum and prevented a harmful reinfestation for 50 days. In another test a spray of E-1059 1-16000 followed in three weeks by a soil drench at the rate of 1½ pints per square foot was still giving complete protection after 76 days.

On roses in benches mulched with corncobs, E-1059 diluted 1-16000 failed to give satisfactory results at a dosage of 1 quart per square foot, but when applied at 2 quarts per square foot, it reduced a population of 90.2 spiders per leaf in four replicates to 0.65 spiders per leaf and maintained that protection for three weeks. A spray of this formulation in a 0.1 percent solution completely controlled an infestation of 8.9 spiders per leaf and allowed a buildup of only 1.45 spiders per leaf in 31 days.

**New Sprays Control Pest which Threatens Birch Trees.** (W. W. Cantelo.) The most spectacular and destructive insect pest of shade trees in 1950, especially in eastern Massachusetts, was the birch leaf miner, *Fenusa pusilla*. Although the common grey birch was the most heavily infested species in the area, all species and varieties including twenty rare kinds at the Arnold Arboretum were attacked.

This sawfly has four annual generations with the adults appearing about May 15, June 25, July 25, and August 30, and all newly opened leaves may be infested. Since nearly all leaves are newly opened in May, the first generation causes the most injury.

Preliminary laboratory studies with insecticides indicated that parathion, DDT, and toxaphene were quite effective in preventing oviposition but that parathion caused some leaf injury. BHC 25 percent gamma and chlordane killed large numbers of eggs, and BHC gave 100 percent control of larvae.

In field experiments, toxaphene (40 percent wettable powder 3 pounds per 100) was significantly effective in killing the eggs. However, the most practical treatment was spraying when the majority of the larvae had hatched but had not enlarged their mines enough to

damage the leaf seriously. As a larval spray, BHC (25 percent gamma isomer 3 pounds per 100) and toxaphene (40 percent wettable powder 3 pounds per 100) were the most effective treatments. They will be the recommended treatments for the coming season.

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## FEED AND FERTILIZER CONTROL SERVICES

John W. Kuzmeski in Charge

Feed, fertilizer, and milk testing laws are administered as one service, and the operations of each, with the exception of the milk testing law, are reported in annual control series bulletins.

Under the milk testing law 4,907 pieces of Babcock glassware were calibrated and 212 certificates of proficiency in testing were issued. All milk depots and milk inspection laboratories in the Commonwealth were visited at least once to check apparatus and general conduct of the work.

In addition to the regulatory work, the Feed and Fertilizer Control laboratories have examined feeds, fertilizers, and other agricultural materials for citizens of the Commonwealth without charge whenever the results were considered of interest to the general public or to the Control Services. Samples of feed, stomach contents, and viscera of animals have been tested for the presence of toxic ingredients.

Considerable work has been done on research projects in cooperation with other departments of the University and Experiment Station. The results of such work are reported by the departments originating the projects.

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## DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

**"Time-Pinching" Produces Good Flower Spray Formation on Pompon Chrysanthemums.** (N. W. Butterfield, Waltham.) From experiments at the Waltham Field Station, it has been found that "time pinching" is the best method of producing good flower spray formation on chrysanthemums. Catalogs of many companies that sell rooted cuttings list the dates when individual varieties should be pinched. The rooted cuttings should be planted directly from the propagating sand into the bench 14 days before the date of time for pinching the variety. Cuttings taken earlier, allowed to become hard and then pinched, produce inferior types of spray and inferior flowers.

The grower who wishes to control the type of spray of a particular variety to suit his needs can accomplish this result by manipulation of shade and light. The plants should be shaded from 5:00 P.M. to 8:00 A.M. from August 12 to 19 and given additional light to 10:30 P.M. from August 19 to September 1. With some varieties, the length of the laterals will be increased, and a larger number of flowers will be produced. In those varieties that have a tendency to produce compact clusters of flowers the character of the clusters may be altered by variations of the short and long day periods previously suggested.



The flowering period of a variety may be prolonged from four to eight weeks by giving the plants a day length of 14 hours. This lighting period should begin before the flower buds set normally, preferably by August 1, the additional light should be given from 6:00 P.M. to 10:00 P.M. A required light intensity of 15 to 20 foot candles is provided by the use of 40 watt bulbs in suitable reflectors placed 40 inches above the plants and spaced at intervals of four feet.

**Spectograph Tests to Determine Causes of Plant Ailments.** (N. W. Butterfield, Waltham.) In the fall of 1950 a rose grower came to the Waltham Field Station with the problem of spots that develop on rose petals during shipment to market. It was found that spots developed to a greater extent in the spring and fall months during which times a product containing sodium antimony lactophenylate was used to control thrips.

Antimony is reported to be very toxic to plant tissue, but no reports were found indicating that this substance was toxic if used at the recommended rates. Since it appeared that this product might cause the spotting, samples of normal and spotted petals were taken to the Laboratory of the New England Spectograph Company for analysis on the spectograph, a modern instrument that will test for 69 chemical elements even if these chemicals are present at very low concentrations. The spectograph test is rapid and requires a minute amount of plant tissue.

The result of this test indicated that the spotted petals were high in antimony, whereas the normal petals did not show the presence of the element. Since antimony, therefore, was considered to be the cause of the spotting, its use was discontinued.

**Flower Growers, Watch Soluble Salts!** (N. W. Butterfield, Waltham.) The presence of soluble salts in soil has a harmful effect on the production of florists' crops. Severe injuries have developed on such crops as snapdragons, chrysanthemums, and carnations. Because of the increasing scarcity and expense of good soil, there is less annual changing of greenhouse soils. In addition, with new methods of production, more fertilizer is now added to the soil, thus causing such an accumulation of soluble salts that plant growth is injured.

Experiments have shown that three applications of gypsum (calcium sulfate), at two pounds per 100 square feet of bench per application, double the normal soluble salt content of the soil. The calcium is used up by the plant or absorbed by the soil, leaving behind the sulfate radical, which plants do not use in their diet.

Soluble salts may accumulate from using too much manure. This accumulation is noticeable in particular after sterilization of soils that contain high percentages of manure. Overfeeding, improper watering, and allowing benches to become dry are other causes of soluble salt accumulation.

Proper leaching of the soil will keep the soluble salts within a safe range. For some soils, two gallons of water per square foot is sufficient; for others, particularly heavy soils, five gallons may be required. The best time to leach the soil is before the old plants are removed. A soil test should be made just before the plants are taken out; if the salts

are found to be high (80 to 100 on the International System), the soil should be thoroughly leached before taking out the old crop. When mature plants are left in the bench, they aid in drying out the soil. Puddling and uneven leaching will result if the soil is leached after removal of the crop.

**The Control of Red Spider Mites on Sweet Peas with a Systemic Insecticide.** (Harold E. White.) Among the many recent materials found outstanding for control of insect pests are the compounds known as organic phosphates. Some of these well-known insecticides are Parathion (paranitrophenyl diethylphosphate), HETP ((hexaethyl tetraphosphate), TEPP (tetraethyl pyrophosphate) and TEDTP (tetraethyl dithiopyrophosphate). These organic phosphate materials have been offered on the market under several trade names, suitable for use as liquid sprays, dusts, and aerosol bombs.

Recently another phosphate material, OMPA (octamethylpyrophosphoramide), has attracted considerable interest because, when applied to soils in a water solution or to the foliage of plants, it is absorbed by the plant tissues. Insects, particularly sucking kinds, such as red spider mites and aphids or plant lice (green fly), are killed when they feed on plants treated with OMPA. Chemicals of this nature, which are absorbed or taken into the internal system of plants, are termed systemic poisons; hence, we have a method or procedure of treatment of plants for insect control known as systemic plant therapy.

Compared with sodium selenate, which is also a systemic poison, new phosphate insecticide has certain advantages in that it does not, so far as is known, remain indefinitely in the soil or plant tissues. Also, it is reported harmless to beneficial insects known as predators and pollinating insects such as bees. The new OMPA insecticide should be treated with the same respect and precautions given for handling other organic phosphate insecticides, as all are poisonous. OMPA insecticide is offered to the public under such trade names as Pestox, Systox, and others.

This new material has been used experimentally on a number of plants such as Roses, Lilies, Chrysanthemums, and Saintpaulias. Some forage crops and vegetables have been treated, but *OMPA should not be used on such crops until further tests are made.*

Tests herein reported deal with the use of octamethylpyrophosphoramide on Sweet Peas for control of red spider mites. Sweet Peas of the Cuthbertson strain, variety Lois, were grown under glass in 6-inch clay pots. The soil was treated with water solutions of OMPA when the plants were 8 inches high, on April 30. The chemical obtained from the Dow Chemical Company, Midland, Michigan, under the number C-1014, was indicated as containing 63.3 percent of technical grade octamethylpyrophosphoramide.

The soil in which Sweet Pea plants were growing was treated with 4 different strength water solutions of OMPA; namely, 1 to 200, 1 to 400, 1 to 800, and 1 to 1000. These dilutions are, respectively: 4 tsps., 2 tsps., 1 tsps., and  $\frac{3}{4}$  tsps. per gallon of water. The amount of solution applied to each pot of soil was 100 ml. or approximately  $3\frac{3}{4}$  fluid ozs.

The Sweet pea plants were artificially inoculated with red spider mites 7 days previous to treatment. Only one application of OMPA to the soil during the 60-day test period was found to be very effective in the control of red spider mites. Dilutions of 1 to 200 and 1 to 400 gave complete control, whereas to 1 to 800 and 1 to 1000 were quite effective as compared to untreated plants. Injury to the plants from any of the treatment was not indicated, and the plants flowered normally.

At the end of 50 days, the untreated plants, compared to treated plants, lost most of their leaves from infestation of red spider mites and were much lighter in foliage color. The treated plants were still in good condition in mid-July and are being maintained to determine the length of effectiveness of the different treatments and to allow seeds to develop to determine whether the OMPA is transmitted to the seeds.

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## DEPARTMENT OF FOOD TECHNOLOGY

Carl R. Fellers in Charge

**Pasteurized Fresh Whole Cucumber Pickles.** (W. B. Esselen, Jr., E. E. Anderson, I. S. Fagerson, L. F. Ruder, Jr., and M. Labbee.) Within the past 15 years, Country Style, Kosher Style Dill, Old-Fashioned Dill, and other pickles of this type have gained wide public acceptance. These unfermented pickles are made by packing fresh cucumbers in jars, covering them with a brine of low concentrations of salt and vinegar, adding essential oils, dillweed, garlic, and spices for flavoring, and finally pasteurizing to destroy microorganisms that might cause spoilage or to inactivate enzymes producing off-flavors during storage.

In the laboratory and in some commerical pickle plants, data have been obtained for evaluating variations in heating rates, processing values, brine volume to acidity ratios, firmness, and pasteurization requirements to prevent spoilage in pickles. An important cause of the great variation in the rate of heat penetration into quart jars of fresh whole pasteurized pickles was found to be the nonuniformity of pickles as packed. Pasteurization times and temperatures adequate to prevent spoilage had no adverse effect on the firmness or flavor of the pickles.

Occasional off-flavors are due to substances called enzymes within the pickles; these enzymes possess greater heat resistance than the common spoilage agents, bacteria and yeasts, in pickles. Pasteurization times derived from this investigation were adequate to destroy both microorganisms and enzymes responsible for either spoilage or off-flavors in pickles.

**Salt and Acid Tolerance of Spoilage Organisms.** Pickle spoilage organisms were capable of growing and causing spoilage in pickles and of growing in pickle brine containing 5.5 but not 6.5 percent salt and in pickle brine containing 1.4 but not 1.6 percent acetic acid. Thus, the brine in jars of fresh pack whole pickles, which usually contains from 0.4 to 0.9 percent acetic acid and about 2.5 percent salt, could not be expected to prevent the growth of spoilage organisms. Likewise, because of their acid and salt tolerance it would not be practical to prevent spoilage in this type of product by increasing the acid or salt content of the brine.



*Heat Resistance of Spoilage Organisms.* The heat resistance of a yeast that caused spoilage in pasteurized fresh whole pickles decreased with increasing concentrations of acetic acid in the brine. Within practical limits, the salt concentration of the brine had no significant effect on heat resistance. The addition of a Kosh-A-Dill essential flavoring oil mixture in the brine exerted a definite effect in decreasing the heat resistance of the yeast. Mustard oil exerted a similar effect.

*Peroxidase in Acid Foods.* (W. B. Esselen, Jr., M. Labbee, and E. A. Nebesky.) Previous work in this department has shown that peroxidase is one of the most heat resistant enzymes found in plant material. When this enzyme is not inactivated it has been implicated as a cause of off-flavor and discoloration in processed foods. Heat treatments adequate to destroy enzymes in food products, under various conditions, may be calculated by an integration of the rate of heat penetration into the product with the destruction rate of the enzyme in the particular product under consideration.

*Peroxidase in Fresh Cucumber Pickles.* A general correlation has been observed between the intensity of peroxidase activity and the development of off-flavors in fresh cucumber pickles. It would appear that to prevent such off-flavors caused by peroxidase activity, it is necessary only to provide sufficient heat treatment to reduce the enzyme activity to a low level rather than to destroy it completely.

*Apple Juice.* When apples are bruised, crushed, or ground, they release an extremely active oxidizing enzyme that causes a rapid browning of the flesh and liquid portion of the fruit. This reaction causes the flavor of the natural apple juice to develop a ciderlike flavor. The enzyme peroxidase is believed to be directly implicated in this change. To retain a maximum of fresh apple flavor in apple juice, therefore, it is necessary to inhibit or inactivate the peroxidase as soon as possible during the manufacturing process. During the past season, data on the thermal inactivation times for peroxidase in Baldwin, Red Delicious, and McIntosh apples were obtained and applied successfully in an apple juice processing plant. The stability of peroxidase towards heat may vary with different varieties of apples.

*Cranberry Investigations.* (W. B. Esselen, Jr., E. E. Anderson, I. S. Fagerson, C. R. Fellers, and M. Tatro.) (In cooperation with the Massachusetts Cranberry Experiment Station, East Wareham, and the National Cranberry Association, Hanson, Massachusetts.)

In 1949, it was found that conditions under which cranberries were grown had a significant effect upon the composition and jelling properties of the fruit. During the past year, studies of fruit grown on two different bogs in New Jersey confirmed these findings. Likewise, a study of fruit from several selected bogs in Massachusetts indicated an effect of bogs and growing conditions on the composition, quality, and benzoic acid and pectin content of cranberries. The practical significance of these observations has yet to be determined; however, a high pectin content in cranberries is conducive to good yields and quality of cranberry sauce.

**Rodenticide Investigations** (L. R. Parkinson). The extreme variability in the quality of Fortified Red Squill offered for sale in Massachusetts this past year seems to be due to the poor crop of crude squill produced in 1950.

Warfarin (Compound 42) [3-(alpha-acetonylbenzyl)-4-hydroxycoumarin], a recently discovered rodenticide, has become very popular in rodent control operations throughout the country, and sensational publicity has given it high public acceptance. The results of check tests and other tests in progress indicate that some of the claims made for Warfarin are somewhat exaggerated; however, this material appears to be one of the best rodenticides yet developed.

**Nontoxicity of Ethylenediaminetetracetic Acid (Sequestrene).** (C. R. Fellers, L. R. Parkinson, and S. S. Yang.) The feeding tests reported a year ago have been extended somewhat. A 5 percent level of Sequestrene in the daily ration was fed. This level of feeding, being abnormally high, might be expected to prove somewhat toxic; however, the rats on this feeding level have shown only slightly less growth than the controls, probably because of their smaller food intake. (*T.D.N.*) No deaths have occurred at this level for the past 15 months. Post-mortem examinations, including microscopic tooth studies, have not shown any observable differences from the controls.

**Frozen Concentrated Citrus Juices as Sources of Ascorbic Acid (Vitamin C).** (E. E. Anderson and I. S. Fagereson.) Varietal differences in citrus fruits as well as unfavorable storage conditions on the part of the manufacturer, wholesaler, and retailer have been known to influence the final ascorbic acid content of frozen citrus concentrates. Furthermore, many people rely on citrus juices as the major source of ascorbic acid. Thus, with the tremendous increase in both production and popularity of the frozen citrus concentrates, it was considered desirable to determine their ascorbic acid content at the time of purchase in the retail market. It was observed that not only was there considerable variation in the ascorbic acid content between different brands of concentrate but even within some samples of the same brand. The latter was usually true when concentrates sold under the same label were packed in different plants or by different companies.

In general, the average vitamin C concentration of all brands approximated 45 milligrams per 100 milliliters of reconstituted juice with extreme ranges of 28.7 to 51.2 milligrams.

**Discoloration of Strained Apple Sauce.** (G. E. Livingston, I. S. Fagereson, and W. B. Esselen, Jr.) To find the fundamental causes of storage browning in many types of strained fruit and vegetable products, apples were selected because they do not possess strong natural pigments, which, by undergoing storage changes, might interfere with the observation of the development of color changes associated with the so-called "browning reaction."

An experimental pack of apple sauce is being studied for quantitative changes in some of the constituents believed to be related to the nonenzymatic discoloration. These include malic acid, the sugars (glucose, fructose, and sucrose), pectin, and 5-hydroxymethyl-2-furaldehyde, which has been identified previously in storage-browned apple sauce. The chemical nature of this furaldehyde compound, a sugar breakdown prod-

uct, is such that it is believed to be an intermediate in the formation of substances causing browning. The effect of certain variables, upon the above constituents and upon the development of color formation, is also being studied in this pack. These variables include storage temperature, head space gases, cap metals, skin pigments, malic and ascorbic acids, glucose, fructose, and sucrose.

As an additional means of elucidating the chemical reactions that cause discoloration in apple sauce, a study of possible interactions between single constituents of apple sauce was initiated using pure chemicals. Of the primary constituents only, a mixture of fructose and malic acid in solution was found to react to form dark-colored products. This system is being studied to determine the rates of reaction, the effect of atmospheric gases, and temperature, and the nature of the substances formed.

**Heat Transfer in Commercial Glass Containers during Thermal Processing. II.  $F_0$  Distribution in Foods Heating by Convection.** (I. S. Fagerston, W. B. Esselen, Jr., and J. L. Licciardello.) Previous work on heat transfer in glass containers utilizing 1 percent bentonite suspensions to obtain convection type heating indicated that minimal  $F_0$  values did not occur on the vertical axis of the container but were found between the vertical axis and the jar wall. In view of the fact that sterilizing processes for foods are generally based on the assumption that these  $F_0$  values or sterilizing values are found on the vertical axis, it seemed desirable to determine the significance of off-center minimal sterilizing or process values in actual foodstuffs that exhibit convection type heating. Accordingly, heat penetration studies were made on three such types of food products; namely, cut green beans, diced carrots, and apple juice.

Although these minimal sterilizing values were also found in the food studied, the magnitude of these values indicates that the effect is much less pronounced on foodstuffs than in 1 percent bentonite suspensions. Although nonsymmetrical process value distribution apparently occurs in foods heating by convection, it appears to exhibit at most only a small effect on the calculated process values.

**Dietetic Fruit Packs.** (E. E. Anderson, W. B. Esselen, Jr., and C. R. Fellers.) A noticeably expanding interest on the part of food processors manufacturing dietetic foods has been evidenced in recent years. That type of dietetic pack wherein sugar is replaced with a noncaloric sweetener is of special interest to the million or more diabetics in the United States. In addition, such foods are in considerable demand by people who are attempting to lose weight or are otherwise restricted in their intake of carbohydrates.

Recently, a new noncaloric sweetener, "Sucaryl Sodium" (Sodium cyclohexylsulfamate) has been made available, and is about thirty times sweeter than sucrose. It is claimed to have the following advantages over saccharin when used in canned fruit: 1) no bitter after-taste if used in moderate amounts and 2) no decomposition in cooking, baking, or boiling temperatures.

With experimental packs of canned sweet cherries, raspberries, and blueberries little difference was noted between the standard sugar and the "Sucaryl Sodium" packs. However, with both peaches and pears,



sirups prepared with "Sucaryl Sodium" lacked the "body" or viscosity of the standard sucrose sirup. Initial attempts to incorporate small amounts of pectin and other thickeners in the "Sucaryl Sodium" sirups to increase their viscosity met with some success.

Canned fruits sweetened with saccharin were less desirable than similar packs prepared with either sucrose or "Sucaryl Sodium."

**Prepeeled Potatoes.** (E. E. Anderson, D. E. Westcott, and W. B. Esselen, Jr.) In view of the fact that hotels, restaurants and other institutions have exhibited considerable interest in prepeeled potatoes, investigations were carried out to find the most effective way of prolonging the storage life of this item.

Potatoes are generally prepared by peeling, chemically treating to prevent discoloration, packaging, and finally refrigerating until needed by the consumer. The more obvious advantages of the prepeeled over the regular potato include the elimination of 1) labor and time for peeling, 2) waste disposal problems, and 3) bulk storage. In addition, some prepeeled-potato operators are considering separating their stock, by means of differences in specific gravity, into different categories of cooking potatoes (i.e., bakers, boilers, etc.), thereby providing their customers with potatoes of uniform cooking quality.

Inasmuch as raw peeled potatoes discolor within a few hours if exposed to the air, various chemical dipping treatments were evaluated for their ability to prevent or delay effectively this discoloration.

Since salts containing available sulfur dioxide were the most effective of all the chemicals evaluated, the following treatments are those that resulted in storage lives of at least three weeks when the peeled potatoes were packaged and stored at 35°F:

- a) Immersion of the peeled potatoes for 15 seconds in an aqueous solution of sodium bisulfite containing 10,000 parts per million (p.p.m.) of available sulfur dioxide (1.62 pounds of sodium bisulfite in 12 gallons of water).
- b) Dipping the peeled potatoes for eight minutes in an aqueous solution of sodium bisulfite containing only 3000 p.p.m. of available sulfur dioxide, that is, approximately 0.54 pounds to 12 gallons of water.

**Quality of Processed (Canned and Frozen) Foods.** (I. S. Fagerson, E. E. Anderson, C. R. Fellers, and K. M. Hayes.) During the past year, considerable work on evaluating the quality of various commercially canned and frozen food products has been carried out. The purpose of the investigation was to determine the general level of quality available to the consumer at the retail level. Items representing the most popular brands were purchased in major cities over the entire country. Products examined include canned baked beans, canned tomatoes, fruit cocktail, tuna fish, frozen fish, fillets, sweet potatoes and green snap beans. Only canned sweet corn and fruit cocktail are discussed here.

Six samples each from 30 to 50 principal brands of a food commodity were evaluated using the United States Department of Agriculture Standards for Grades whenever applicable grades existed.

*Canned Corn.* Of 39 leading brands of canned corn tested, 20 were cream style and 19 were whole kernel packs. On the basis of retail prices paid for the same brand, whole kernel corn was generally more expensive than cream style corn. Whole kernel corn was also more expensive when vacuum packed than when brine packed; however, in all types of pack, retail prices generally provided no reliable guide to quality.

Of the 20 brands of cream style corn, only two met the standards for U. S. Grade A or U. S. Fancy; 11 were U. S. Grade B or U. S. Extra Standard; four were U. S. Grade C or U. S. Standard; and three were U. S. Grade D or Substandard.

Of the 19 brands of whole kernel corn, eight met the specifications for U. S. Grade A and 11 were U. S. Grade B.

*Canned Fruit Cocktail.* The importance of this commodity is evidenced from the fact that in 1949 canned fruit cocktail reached third in size of all canned fruit packs. In general, the over-all quality of this canned product, as purchased on the retail market, was fairly high. Again, price alone was no indication of the quality of the contents. Of the 32 brands examined, 18 were U. S. Grade A; 11, U. S. Grade B; and three, U. S. Grade D or substandard. Prices paid for the regular family size can (#2½) ranged from a low of \$0.33 to a high of \$0.54.

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## DEPARTMENT OF HOME ECONOMICS NUTRITION

Anne Wertz in Charge

**The Nutritional Status of Pregnant Women.** (A. W. Wertz, M. E. Lojkin, G. C. Hagan, C. E. Dietz, and L. Guild.)

A study of the nutritional status of expectant mothers and its relationship to complications during pregnancy and to the physical condition of the child at birth was carried on in conjunction with the Northeast Regional Cooperative Project on Nutritional Status. Methods in this study included (1) dietary studies, (2) biochemical studies of blood and urine, and (3) physical and medical examinations of mother and child. The final treatment of the experimental data will be correlation studies between the findings of the different methods used. These correlations will be made not only to determine the nutritional status of the individuals studied, but also to evaluate each method as a means of assessing nutritional status. In addition to these correlation studies, evaluations of the physical condition of the child at birth and the possible influence of the mother's nutritional status on the complications during pregnancy and parturition will be made. Although such interpretation of the data has not yet been possible, there are several interesting facts that have become evident in the course of the study.

One of the major problems in this study was concerned with finding in the most satisfactory and feasible manner just what an individual eats and how much. It has been found that, if the food intake of a homemaker is obtained by an interview between the homemaker and a dietitian, the homemaker usually overestimates the amount of food that she eats in comparison with an actual record of the food eaten. The amount of food nutrients that are consumed by an individual from day to day varies

greatly. To obtain a true picture of the adequacy of a person's diet, it is necessary to have a record of the food consumed for several days.

By the use of the interview and food record techniques, the dietary habits of 75 expectant mothers have been studied at least for two and usually for three seven-day periods. The nutrients in the foods eaten have been calculated by the use of food value tables, and the adequacy of the dietaries evaluated by the use of the table of Recommended Daily Dietary Allowances set up by the Food and Nutrition Board of the National Research Council. These allowances for nutrients have been recommended as ideal levels at which to aim; but it does not necessarily mean that failure to attain these levels indicates a state of malnutrition. It has been found that only one woman of the 75 studied consumed a diet adequate in all nutrients as recommended for women in the latter half of pregnancy. Two other women met the recommended daily allowances in all nutrients except calcium. The majority of the diets were low in all or several of the eight nutrients studied. The number of diets meeting the recommended daily allowance for thiamine was 8 percent; iron, 14 percent; calcium, 16 percent; riboflavin, 18 percent; protein, 22 percent; niacin, 28 percent; ascorbic acid, 40 percent; and vitamin A, 68 percent. More of the diets were adequate in ascorbic acid and vitamin A value than in any of the other nutrients. A higher percentage of the diets was surprisingly inadequate in thiamine, iron, calcium, riboflavin, and protein. Many of the diets could have been brought up to the adequate level by the addition of milk and meat or other foods in small amounts; however, some of the diets were so grossly inadequate that drastic changes should have been made.

With the idea in mind that the adequacy of the mother's diet might be directly dependent upon the income of the family or more closely upon the amount spent for food per person by the family, a study was made of the adequacy of the mother's diet in relation to the amount of money expended for food. In the cases studied, no correlation existed between the adequacy of the mother's diet and the amount of money spent for food. This fact suggests that the education or interest of the homemaker in food nutrients and requirements rather than the amount of money available for food might be the determining factor in what she buys.

Blood and urine samples were taken from the women at different stages of pregnancy. This blood was analyzed for hemoglobin, ascorbic acid, carotene and vitamin A values.

A summary of the data indicates that the blood values of these nutrients for the majority of the women fall in either the medium or high range. The fact that a lesser number of women are in the high range for hemoglobin than for the other nutrients may be a reflection of the low dietary intake of protein and iron. As yet the data have not been analyzed to determine whether the women with the lowest intake of dietary nutrients are the women with the lowest value for the blood nutrients. Neither have the analytical data on the urinary excretion of nutrients been correlated with the dietary or blood data. Until these studies are completed it will not be possible to discuss these data in respect to the over-all nutritional status of the women.

The results of the physical examinations have not been summarized completely or correlated with the dietary or biochemical data. However,



it is evident that several of the women studied showed some clinical signs (usually to a slight degree) during pregnancy that might be attributed to an insufficient amount of some of the food nutrients in their diets. An evaluation of the significance of these findings must await completion of the study.

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## DEPARTMENT OF HORTICULTURE

Clark L. Thayer in Charge

### Chemical Sprays Help Control Weeds in Nurseries. (C. J. Gilgut.)

In a comparison of various weed-killers for control of weeds in nurseries Sovasol No. 5 (Stoddard Solvent) gave more satisfactory results than dinitro or 2,4-D preparations. Weeds are killed better, especially grasses, and in greater variety, reducing considerably the amount of respraying necessary to control those that survived a previous spraying.

Chemical weed control does not replace cultivation between rows but it does reduce the amount of hand hoeing necessary in the row where weeds cannot be reached by horse or power cultivator. It is economically feasible, for in many instances weed control in the row has been accomplished at one-third the cost of hand hoeing. If applied while the weeds are still small, less than 4 inches high, the cost is still less because applications are made faster, weeds are killed better, and less material is used.

Seeds of the common weeds are not killed by thorough wetting with Sovasol No. 5, but germination is delayed, extending the time necessary between applications of weed killer and reappearance of weeds.

Unfortunately Sovasol No. 5 is not selective and will injure nursery plants, although some are more tolerant to small amounts than others. Coniferous plants, such as pines, spruces, junipers, and hemlocks, show only slight injury from drift or accidental light application. If the bark on the trunk at the base of these plants is soaked intentionally or through carelessness, or if the oil runs down the stem to the roots, invariably the plants are killed. Yews are highly susceptible to injury by the oil; leaves, stems, and even older bark at the base of the stem are easily injured and Sovasol used near them should be applied with great care. Leaves of deciduous plants are damaged easily and also the more tender, thin bark on twigs and stems; but the older, heavier bark is less easily injured.

Up to the present time, the best method of applying Sovasol to weeds in the nursery row is with a 3-gallon pump-up type sprayer equipped with about 5 feet of hose and a flat spray nozzle. This type of nozzle wets the weeds better than the conventional nozzle used for pest control, and spray application can be controlled better so that nursery plants are not wet. The height at which the nozzle is held from the ground determines the width of the band of spray applied: if needed, the width can be reduced to a narrow line. Where it is not feasible to spray weeds close to the plant because of danger of injury, the hoe has to be used. But where the oil is applied, the weeds are killed completely, even purslane which is difficult to control by hoeing. Since the soil is not disturbed, new weed seed is not turned up; in wet or heavy soil, weeds are killed and not replanted, as with hand hoeing.

## DEPARTMENT OF OLERICULTURE

Clark L. Thayer in charge

**Hormones on Trellis Tomatoes.** (Robert E. Young, Waltham.) Some experimental workers have reported the advantage of using hormone sprays on field tomatoes to increase the set of fruit and hasten maturity. To determine the value of these hormones for growers of trellis tomatoes, para chlorophenoxyacetic acid was used at the rate of 30 parts per million. This was sprayed on the bottom cluster when three flowers were open. Treatment was repeated one week later. The results of this experiment have shown that in a cool year the hormone spray increased the number of flowers set as much as 40 percent. In a normal year the increase was only 6 percent, and in a warm year there was no increase. Maturity, however, was hastened by the hormone spray in all three years.

In 1950, a year in which there was no increase in the set of blossoms, the sprayed plants produced 385 baskets of tomatoes up to August 3, whereas the unsprayed plants produced only 213 baskets per acre. This hastening of maturity of the bottom cluster delayed the maturity of the second and third clusters somewhat but did not decrease the total yield.

This material is not too costly, and application does not require much labor. It should, however, be used with care, following the directions of the manufacturer.

**Breeding Sweet Corn, Peppers, and Field Tomatoes for Massachusetts.** (William H. Lachman.) Two sweet corn varieties, Pilgrim and Golden Jewel, released several years ago have become standard varieties for Massachusetts.

Gold Mine sweet corn was introduced recently to the trade and was well received where planted on fertile soil. Gold Mine has been in our trials for six years and has repeatedly matured earlier than all other commercial hybrids with which it has been compared. A new experimental hybrid tested this year, with a slightly better ear and stalk, matured one day earlier than Gold Mine.

Another new hybrid, Barbecue, in season with Pilgrim, has an exceptionally long, attractive ear of good quality and has yielded well in our tests. A considerable amount of seed was sent out to farmers for testing in 1951.

The main object of the breeding problem now is to incorporate higher quality into the early hybrids by using a glumeless type as well as a super-sugary type corn.

From hundreds of tomato crosses made in recent years one hybrid has performed very well in field trials. This variety is made by crossing Red Cloud to Pennheart. It has a determinate compact plant with clusters set very close together on the stem and combines the vigor and size of Pennheart with the smoothness of Red Cloud. This variety has consistently yielded more early fruit than any other variety in our trials. A number of seed samples were sent out for trial among farmers in 1951.

A further search for desirable early tomato hybrids is being made with the object of incorporating firmer fruit with less tendency to crack.

**Weed Control in Vegetable Crops.** (William H. Lachman.) Experiments involving chemicals for controlling weeds in sweet corn indicate that Granular Cyanamid, sodium pentachlorophenate, 2,4-D, and Premerge are adapted to this purpose in pre-emergence applications.

Granular Cyanamid at the rate of 400 pounds per acre applied one or two days before the corn plants emerge prevented growth of annual weeds for three to four weeks. Fifteen to twenty pounds of sodium pentachlorophenate per acre, one and one half pounds of 2,4-D (acid equivalent) and three to six pounds of DNOSBP in Premerge were all very effective in preventing annual weed growth in sweet corn when applied to the soil immediately after planting the seed.

Premerge and sodium pentachlorophenate were also effective in controlling weeds in snap beans.

Sodium pentachlorophenate at ten pounds per acre and Granular Cyanamid at 400 pounds per acre in pre-emergence applications appreciably reduced the stand and size of weeds in set onions.

**Culture and Nutrition of Vegetables.** (William H. Lachman.) Stokesdale tomatoes treated with Sure-Set (p-chloro phenoxyacetic acid) produced earlier and larger tomatoes than untreated plants. The open blossoms of the first two flower clusters were treated twice with this chemical with the aid of a nasal atomizer. Two pickings were made from the treated plants before any ripe fruit appeared on untreated plants.

Sweet Spanish onions grown from plants performed exceptionally well in our experiments, as well as in cooperative tests with farmers. Onion F<sub>1</sub> hybrids proved to be more uniform in size and shape than ordinary varieties, and two of these hybrids outyielded four commercial standard strains of Sweet Spanish onions.

Our experiments have shown that it may be possible for farmers to predict the harvest date of sweet corn at the time of planting since individual varieties apparently require a rather uniform amount of heat to bring them to maturity. Successive plantings of sweet corn require great differences in regard to days to ripen but require essentially the same number of heat units to reach maturity. These heat units are figured as daily temperatures in excess of 50° F. and are accumulated from the date of planting until harvest. When successive plantings are compared on this basis, early, midseason, and late plantings all require approximately the same number of heat units to ripen.

**New Varieties of Broccoli<sup>1</sup>.** (Robert E. Young.) Two new varieties of broccoli, Waltham No. 11 and Waltham No. 29, developed as a result of several years breeding work, have proven very desirable to market gardeners who have had them in large scale trials. Waltham No. 11 can be grown in the spring and also in the fall, but Waltham No. 29 must be grown as a fall crop.

The Waltham No. 11 is not distinctive as to type. It was bred to produce a large proportion of the crop at one time in order to reduce the cost of harvesting. Compared with other varieties, it is early when grown in the spring but only midseason when grown in the fall. In spring trials by market gardeners, and at the Waltham Field Station, this variety has produced a larger crop of marketable broccoli than any



of the other varieties tested. Much of this increase is due to the elimination of plants that produce either a poor head or no crop at all. The heads of Waltham No. 11 are medium large, dark green, with small buds that remain tight for several days.

The Waltham No. 29, which requires warm weather for its proper development, can be used only as a fall crop in Massachusetts. The plants are different from other varieties in that they are short and compact with many side shoots that develop just above the soil line. The plant and head are slow growing. Waltham No. 29 is not easily affected by periods of hot weather which occur in the fall, thus giving the grower an opportunity to let the heads develop fully without danger of losing them because of opening buds. This variety produces a very large head with many heavy stems under the buds, which gives the grower a larger crop and the consumer a higher quality product. This is also a desirable character for the freezer since most of the head, when cut to a 6-inch length, comes apart in many of the smaller heads of freezing size. Waltham No. 29 broccoli is much more uniform in type than Waltham No. 11 and other varieties. It produces 10 to 20 percent larger crop, much of which comes on the large number of side shoots. It also has more cold resistance.

Several hundred acres of each of these varieties are being grown in 1951 on both the East and West Coast. Waltham No. 29 seems to have the widest adaptability. Large-seed growers have been supplied with stock seed.

**Transplanting Lettuce.** (Robert E. Young, Waltham.) Pennlake lettuce will not produce satisfactory heads if planted too deeply. This was proved in two-year trials of transplanted lettuce. When planted too deeply, the plants and heads are very small, and the heads cone-shaped. Some commercial lettuce fields have contained as many as 50 percent of this type of plant, and other fields almost none.

It was found that Pennlake lettuce was much more sensitive to deep planting than Great Lakes. Deep planting caused the heads to mature earlier and so they were too small for marketing.

Trials were also conducted, putting the plants on a small ridge. This caused the plants to be larger than those set on level soil at the regular depth, and they matured later.

Those growers using Pennlake for the lettuce crop transplanted in the field should be sure that the workers do not set the plants too deeply, but at the same depth that they were growing in the flat where they were started.

**The Degree of Maturity of Sweet Corn.** (W. Bradford Johnson and Emmett Bennett.) The degree of maturity of sweet corn can be estimated by several methods. One method recently developed at this station is based on the light scattering effect of the components of the kernel when blended and suspended in water. The procedure is highly sensitive, reproducible, and quick. The degree of maturity is evaluated on a relative basis by means of a turbidity index. This factor is obtained by multiplying the percentage of light transmission of the aqueous sus-

<sup>1</sup> The assistance of William Richards, Forestdale, Massachusetts, in the development of these varieties is acknowledged and appreciated.

pension by the amount of dry matter in the sample. The suspension from the more immature sample will contain a greater amount of soluble material and a lesser amount of the relatively insoluble polysaccharide; it will, therefore, transmit a greater percentage of the incident light. In the mature sample the opposite is true, and hence less light will be transmitted through the medium. Varying degrees of maturity will fall within these extremes.

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## DEPARTMENT OF POMOLOGY

A. P. French in Charge

**McIntosh "Bud Sports."** (W. D. Weeks, F. W. Southwick.) One of the problems confronting the fruit grower in the production of McIntosh apples is the failure of many McIntosh trees to produce highly-colored apples which have an over-all red color. Many orchards contain trees that produce poorly colored apples on which the red color is striped. In an attempt to overcome this difficulty, red "bud sports" or strains have been selected and propagated to produce apples that are superior in amount and type of red color.

In the Spring of 1942, an orchard containing six "bud sports" or strains and the so-called standard or striped McIntosh was planted to determine whether there were superior strains of McIntosh with regard to red color development. This orchard has fruited sufficiently for the past three years to determine the performance of the strains. Rogers McIntosh continues to be the outstanding strain because it produces 40 percent more fancy fruit than the regular or striped McIntosh. The crop from the Rogers strain graded out 97 percent U. S. Fancy, whereas the crop from the regular McIntosh graded only 58 percent U. S. Fancy.

Some of the other red strains had redder apples than the regular McIntosh but they all produced some striped apples, whereas the fruit from the Rogers strain was all of the solid red type.

No other differences have developed among the strains to date, but the test will be carried on for a few more years to determine whether the strains have other desirable characters and whether the Rogers strain continues to maintain its superior red color.

**The Nutrition of Apple Trees.** (W. D. Weeks, F. W. Southwick, Mack Drake, and J. E. Steckel.) The effect of different rates and sources of nitrogen on fruit color and the chemical composition of the foliage of seventeen-year-old McIntosh apple trees has revealed some interesting relationships. Trees that received annual applications of 4 and 6 pounds of ammonium nitrate per tree produced fruit of very low red color. Only 18 to 20 percent of the crop graded U. S. Fancy. In contrast, trees that received equivalent amounts of nitrogen in the form of hay mulch produced exceptionally highly colored apples—85 to 90 percent of the crop graded U. S. Fancy. The fruit from trees receiving equivalent nitrogen in the form of complete fertilizer (7-7-7) was intermediate in red color. Trees receiving 20 pounds of complete fertilizer (7-7-7) plus 2 pounds of ammonium nitrate produced fruit that was slightly better colored than that from trees which received 6 pounds of ammonium nitrate.

The color of the fruit from trees receiving nitrogen as spray urea was disappointingly low. Only 46 percent of the crop graded U. S. Fancy.

Determinations of the chemical composition of the foliage from the trees receiving the several treatments revealed that ammonium nitrate increased leaf nitrogen and magnesium and depressed potassium and phosphorus. Hay mulch increased potassium and phosphorus, but depressed nitrogen. Magnesium remained about the same as it was before the treatment was started. Complete fertilizer failed to increase potassium and phosphorus content of the foliage to the same extent as hay mulch.

A definite relationship was established between leaf nitrogen and potassium. As nitrogen increased, potassium decreased. The relationship of leaf nitrogen and potassium to red color development of the fruit showed that as nitrogen increased, red color decreased, whereas an increase in leaf potassium was associated with highly colored fruit. These data suggest that red color development may be partially dependent upon the relative amounts of nitrogen and potassium found in the foliage.

Crop yields have not been materially influenced by the different treatments as yet. The ammonium nitrate plots have had the highest yields.

To determine what effect the competition for plant nutrients by the grass growing under the trees might have with tree performance, grass samples were obtained, and the amount of dry hay per acre was calculated for the different treatments. The greatest amount of grass (3400 pounds dry hay per acre) was found in the plots that received complete fertilizer plus ammonium nitrate. Trees that received 6 pounds of ammonium nitrate had the next highest amount of grass (2700 pounds of dry hay per acre) growing under them. The hay mulch plots had the least amount of grass (200 to 600 pounds dry hay per acre) although the urea sprayed plots were not much better. The greater amount of grass growing under the trees that received both complete fertilizer and ammonium nitrate may help to account for the lower leaf nitrogen and somewhat better fruit color that these trees had in comparison with the ammonium nitrate trees. The lack of grass competition under the mulch trees may account for part of their differences in leaf nitrogen and fruit color which they exhibited in contrast to the performance of trees which had greater competition from grass for plant nutrients.

**Weed Control in Lowbush Blueberries.** (J. S. Bailey and W. D. Weeks.) The growing of lowbush blueberries is an important industry in Massachusetts. In the two towns of Granville and Blandford alone there are 1500 acres with an annual crop valued close to \$100,000.

These blueberry fields require periodic burning to maintain production. Over a period of years this burning lowers soil fertility with consequent reduction in yield. The use of fertilizer to replace lost fertility has not been entirely successful. One reason is that the fertilizer sometimes stimulates weed plants as much or more than the blueberries.

In a blueberry field any plant not a blueberry is a weed. Thus there is a wide variety of weeds to be controlled: grasses, ferns, low growing shrubs, such as bayberry and laurel, and the sprouts from the stumps of trees like maple, oak, and birch.

Although some weed plants are controlled by cutting and burning, many are not. The use of chemicals for the control of the latter looks



promising. Consequently, a search is being made for chemicals which will kill the weed plants with little or no injury to the blueberries.

Gray birch, when cut, will sprout freely from the stumps. This habit makes it a serious pest in many blueberry fields. It is fortunate that gray birch is quite sensitive to the new weed killer 2,4,5-T, a close relative of 2,4-D. In fact, where these two are combined, as in the so-called "Brush Killers," the mixture appears to be more effective against gray birch than the 2,4,5-T alone. Since this mixture at lethal concentration is also toxic to the blueberries, its successful use depends on the way it is applied. The "dormant basal stem" treatment has been found to be very effective. The brush killer mixed with oil (kerosene, Diesel or fuel oil) at the rate of 4 percent by volume, roughly a pint to 3 gallons of oil, is applied during the dormant season to the sprouts from their base up to knee height. Low pressure and a nozzle delivering a narrow fan-shaped spray are desirable. A knapsack spray is satisfactory for this type of work. The lower parts of sprouts and the old stumps should be thoroughly covered, but the blueberries should be sprayed as little as possible.

Sweet fern has grown up so thick in some blueberry fields that it has ruined the production. This weed is easily controlled with 2,4-D. A solution made by adding one pound of sodium salt or 26 ounces of an amine formula (containing 4 pounds 2,4-D acid equivalent per gallon) to 200 gallons of water sprayed evenly over an acre will give almost complete control.

Patches of bayberry often become troublesome in blueberry fields. This is another weed which can be controlled with 2,4,5-T. To avoid injury to blueberries a weak solution must be used. Twenty-six ounces of a 2,4,5-T formula containing 4 pounds acid equivalent per gallon gives a solution containing about 500 ppm. This is sprayed on the bayberries in June or July. Enough is applied to wet the leaves thoroughly without dripping. This first spray will kill the tops to the ground. There will be some resprouting the following year; however, spray on these sprouts will complete the kill of the entire plant.

**The Correction of Magnesium Deficiency in Cultivated Blueberries.** (John S. Bailey and Mack Drake.) Magnesium is one of the elements which plants must get from the soil for normal growth and development. Without magnesium, plants are unable to make green coloring matter, chlorophyll, so vital to their life and health.

Some of the soils of Massachusetts are low enough in magnesium so that plants that have a high requirement for this element will show a deficiency. Among fruit plants, numerous cases of magnesium deficiency in apples have been reported in Massachusetts. The first case of magnesium deficiency in cultivated blueberries in the State was found in the Summer of 1949 in a planting of young bushes in Middleboro. The leaves on affected bushes turned yellow and red between the veins. This discoloration started at the leaf tip and spread along the margins toward the base. Chemical analyses of the leaves verified the visual diagnosis. The average magnesium content of the leaves on a dry weight basis was 0.049 percent. In one sample the magnesium content was 0.030 percent. Even 0.049 percent is extremely low. Also, the soil was found to be extremely acid, pH 3.8 to 4.2.

To overcome this deficiency two of the materials most commonly used for this purpose, Epsom salts and dolomitic limestone, were tried. Varying amounts of each material were applied to the soil and cultivated in. A year later chemical analyses of the leaves showed that both sources of magnesium increased the magnesium content of the leaves.

When Epsom salts was used, increasing the MgO applied from 25 lbs. per acre to 150 lbs. per acre resulted in a steady but not proportional increase in leaf magnesium content. When dolomitic limestone was used, 100 lbs. of MgO per acre was about as effective as 200, 400 or 600 lbs. per acre. One hundred to 200 lbs. of MgO as dolomitic limestone was slightly more effective than 25 or 50 lbs. of MgO as Epsom salts.

Where magnesium deficiency appears in cultivated blueberries, a single application of magnesium at the rate of 100 lbs. of MgO per acre should correct the trouble. Either 500 lbs. of dolomitic limestone (20 percent MgO) or 600 pounds of Epsom salts gives the required amount.

The use of dolomitic limestone to supply magnesium also causes an increase in soil pH. With cultivated blueberries this is not objectionable so long as the pH does not increase much above 5. In this experiment 2,000 lbs. of lime per acre supplying 400 lbs. of MgO increased the pH to just about 5 during the first year. This suggests that for this soil one ton of dolomitic lime per acre is the maximum that should be applied.

**Post-calyx Chemical Thinning of Apple Trees Shows Sufficient Promise for Commercial Usage.** (F. W. Southwick and W. D. Weeks.) In 1948, following a rainy, cool bloom period which restricted bee flight and hence pollination and fruit set, attempts were made to thin apples from 2 to 4 weeks after calyx when the need for thinning sprays could be much more accurately determined than at either blossom or calyx time. Further results obtained in 1949 and 1950 with spray applications made from 10 days to 3 weeks after calyx have been sufficiently promising to warrant commercial usage of this method for thinning. It has been possible by one application of naphthaleneacetic acid after calyx to thin such varieties as Wealthy, Early McIntosh, Baldwin, Red Gravenstein, Kendall, and others in a fraction of the time it could have been accomplished by hand and with less risk of overthinning and foliage injury than could be accomplished by dinitro materials at blossom time or naphthaleneacetic acid at calyx time. Early thinning has resulted in an increase in "marketable" yield (volume of fruit over 2½" in diameter) as compared with unthinned trees. Also, such varieties as Golden Delicious, Wealthy, Opalescent and Red Gravenstein, can be induced to yield annual crops when adequately chemically thinned after calyx. Even such biennial bearers as Early McIntosh and Baldwin have occasionally blossomed in successive years in some orchards following this thinning procedure. However, the factors which influence the degree of abscission following the use of naphthaleneacetic acid are not sufficiently well understood. We are hopeful that as experiments continue and our experience increases we can forecast more accurately the degree of thinning which will result under a given set of conditions. Until then, the possibility of occasionally overthinning with this chemical will be present.

**The Use of Activated Carbon in Apple Cold Storages Has Increased the Marketable Life of Apples.** (F. W. Southwick.) Tests during the past two years have shown that activated coconut shell carbon, either in manufactured units or in suitably designed "home-made" purifiers, will add approximately one month to the storage life of McIntosh and Cortland as determined by firmness of flesh. This is assuming adequate carbon is used, air flow through the carbon is sufficient, and that adequate air distribution exists throughout the room. Under the conditions mentioned various storage odors arising from boxes, the apples themselves, and from other produce have been markedly reduced in most cases. This ability of carbon to eliminate odors has resulted in apples which are free from storage "off" flavors and, thereby, more palatable to the consumer. However, air purifiers employing coconut shell carbon have not given adequate control of storage scald. In fact, for the variety Cortland, air purification with carbon appears to be inferior to shredded oiled paper in this regard.

It is anticipated that following another year of experimentation with "home-made" units designs of 2 or 3 types will be made available for installation in rooms with small, ceiling hung cooling units as well as with the larger floor mounted cold diffusers. It is expected that these "home-made" types can be built at a cost considerably below manufactured units now on the market.

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## DEPARTMENT OF POULTRY HUSBANDRY

Fred P. Jeffrey in Charge

**A New Type of Sex Linkage in the Domestic Fowl.** (F. P. Jeffrey.) Dominant White Plymouth Rock females of the University of Massachusetts strain when mated with Rhode Island Red or New Hampshire males produce chicks that can be identified on the basis of down color with 100 percent accuracy at hatching time. Male chicks are white, and females are light tan or buff. At maturity the males are generally white, and the females are buff or red on the surface and pure white in undercolor. This is the first record of sex determination at hatching on the basis of down color in which the gene for dominant white is involved. Genetically these dominant White Plymouth Rock females carry genes for silver, gold intensifier, and dominant white. Rhode Island Red or New Hampshire males carry genes for gold, gold intensifier, and lack the gene for dominant white.

**Broodiness May Be Completely Eliminated in Rhode Island Reds.** (F. A. Hays.) The broody instinct reduces annual egg production because each broody period is generally associated with about 15 days of non-production. Through selective breeding it has been possible to decrease the incidence of broody birds in our Rhode Island Red flock from about 90 percent to as low as 3 percent. By use of the progeny test combined with hormone tests for carriers of the broody inheritance a line has been developed that exhibits no broodiness in the first laying year. We are now in the third generation of this line in which no broody birds have



appeared. Such stocks are particularly useful in breed or strain crosses where the increased incidence of broodiness has made such crosses undesirable.

**Fertility in Poultry is a Highly Variable Character.** (F. A. Hays.) In pedigreed Rhode Island Reds bred for high fecundity, fertility behaves in a variable fashion. Normally the degree of fertility increases as the season advances from February to April. In pedigreed pen matings a decline in fertility is often observed in successive weeks. Our results indicate that this decline is generally the result of failure of some birds to mate regularly through the breeding season; this can usually be corrected by changing males. Cases have been observed, however, where low fertility resulted not from failure to mate but to incompatibility of male and female germ cells. Our data rather definitely indicate that fertility is regulated in part by inheritance.

**Hatchability has a Strong Genetic Basis.** (F. A. Hays.) Through selective breeding it has been possible to develop two lines of Rhode Island Reds that differ greatly in the percentage of their fertile eggs that hatch. The high line has a mean above 80 percent, and the low line has a mean below 50 percent. The problem now is to discover some of the specific causes of this very low hatchability under good feeding, management, and incubation.

**Breeding for High Fecundity Discloses Many Valuable Facts.** (F. A. Hays.) Winter pause and winter rate of laying have been shown to be intimately related. Birds laying at a slow rate are very likely to stop laying for a time during the winter months, whereas those that lay at a very high rate have very little winter pause. Shell color in Rhode Island Red eggs normally increase between the spring of the first and second laying years. Rapid chick feathering produced by autosomal genes is associated with more rapid early weight increase, but the sex-linked gene has no effect on early growth. Very early sexual maturity in Rhode Island Reds is associated with more rapid chick growth. Hens that lay 300 eggs or more are definitely superior breeders to their full sisters that lay fewer eggs. Considerable success may be expected in selecting superior males on the ability of their daughters to lay at a high rate either in November at the beginning of the year or in August at the close of the year. Trapnesting is required for both periods because some males will be selected because of superior November intensity alone, whereas others are selected on the basis of August intensity alone. Seldom will a male qualify in both categories.

**Photograph of Massachusetts Rose.** (F. A. Hays.) Massachusetts Rose, a Rhode Island Red hen hatched in 1944, is remarkable for her sustained high egg production and for her ability to transmit high production when mated to three different males. A member of the high-producing Massachusetts Experiment Station flock, she has laid 1079 eggs in four years, setting a mark of 330 in her first year and dropping only to 236 in her fourth year.

Her March egg weights have varied from 24.7 ounces per dozen to 26.7; their hatchability ranged from a low of 76 percent her first year to a high of 91 percent her second year. The fourth year it was 86 percent.

Rose had 7 daughters that averaged 245 eggs in 1945. From another sire, she had six daughters that averaged 244 eggs in 1946. In 1947, from a third sire, she had five daughters that averaged 243 eggs plus.

She lays a medium brown egg with good shape and shell texture. A medium red herself, she weighed 5.35 pounds at first egg and now weighs 7½ pounds.

One of a family of 13 sisters who averaged 239 eggs, Rose had one sister who hit 303. Her sire had 23 daughters with an average of 243, and his ten sisters averaged 249 eggs.

**Inheritance of the Length of the Incubation Period of Chickens.** (J. R. Smyth, Jr.) After only one generation of selection, lines differing in regard to the length of the incubation period have been separated. The early hatching line emerged at an average of 20 days and 22.3 hours after the beginning of incubation, and the late hatching line took an average of 21 days and 5.7 hours to complete the incubation period. This difference indicates that the heritability of the length of the incubation period is high in comparison with egg production and many other characters of economic importance. Observations were also made on the effect of the length of incubation period on subsequent growth rate to 8 weeks of age, mortality, and sex of the chicks. The only significant difference was found in the case of post-hatching mortality. The chicks from the early hatching line had a mortality of only 3.03 percent to 8 weeks of age, as compared with a mortality of 10.53 percent for the chicks from the late hatching line. Most of this mortality occurred during the first 10 days following hatching.

**Mating Frequency in Turkeys.** (J. R. Smyth, Jr.) Observations were made of the number of times Jersey Buff turkey hens mated during the first 13 weeks of the 1951 mating season. These observations were made by allowing the toms to be with the hens for a one-half hour period on each of six days per week. In the turkey, the female determines whether a mating will be attempted or not. If a female dropped to the floor and permitted the male to mount her, she was given credit for a mating. This eliminated any differences in the mating efficiencies of different males.

The average number of matings per hen was 9.2 during the 13 week observation period. There was considerable variation between females with 28 matings being the individual high record and zero being the low extreme.

A definite correlation between the number of matings and fertility was observed. Turkey hens mating 1 to 6 times during the period produced 82.9 percent fertile eggs. Those hens mating from 7 to 12 times gave a fertility of 96.1 percent, and those mating more than 12 times produced eggs that were 96.6 percent fertile. One hen in the highest frequency group mated only during two concentrated periods and produced a number of infertile eggs just prior to the second mating spree. If her record were eliminated, the fertility of the highest frequency

group would have been raised to above the 99 percent level. This illustrates the point that the distribution of matings is as important as is the total number. Where a hen mated at least once every 3 weeks, fertility remained at a very high level.

**Length of Life of Turkey Sperm in the Female Reproductive Tract.** (J. R. Smyth, Jr.) The length of time that sperm cells of the turkey tom can survive and fertilize eggs after a single mating is important for several reasons. For one thing, it determines the frequency of natural matings, which is necessary to maintain a high level of fertility. Sperm survival time is also important to those who practice artificial insemination because it determines the best interval between inseminations of the turkey hens. By pedigreeing eggs on a basis of both the dam and the days after an insemination, it is possible to study this subject.

During the past year a study of the Station Jersey Buff flock showed that the average duration of fertility following an insemination was 47.5 days. However, fertility is not maintained at a high level throughout this period. For the first 30 days following the day after insemination, 96.1 percent of 466 eggs laid were fertile. However, during the period from 30 to 40 days following insemination the fertility of 126 eggs laid dropped to 80.8 percent. After 40 days the fertility dropped off to a very low level. These data indicate that if a turkey hen is inseminated at 4-week intervals a very high level of fertility should be expected.

The percent hatch of fertile eggs was also found to remain at a satisfactory level for the 30-day period following insemination. There was an increase in the number of fertile eggs that failed to hatch after this time. This indicates that, in the turkey, old or "stale" sperm cells cause an increase in the incidence of dead embryos.

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## DEPARTMENT OF SEED CONTROL

Frederick A. McLaughlin in Charge

Enforcement of the Seed Law, together with the desire of seedsmen to comply with requirements of this Act, and a growing interest of the public in good seed, have greatly increased the number of service samples sent to the Seed Laboratory for testing. From July 1, 1950, to June 30, 1951, 6137 service and inspection samples of seed were received and tested in the laboratory. The laboratory also received and cleaned 67 lots of tobacco seed.

Analysis of inspection samples indicates that most seedsmen have complied with label requirements of the Seed Law. A large part of the violations found are technical rather than flagrant in nature.

Operation of the Seed Law is reported in an annual control series bulletin issued for that purpose.



## DEPARTMENT OF SHADE TREE LABORATORIES

Malcolm A. McKenzie in Charge

During the past year, numerous inquiries were received concerning a disease known as oak wilt which has been reported on native oaks in the Midwest and as far east as central Pennsylvania. A fungus, *Chalara quercina* is reported as the causal organism. Dying oaks have been found in all parts of Massachusetts, but the oak wilt fungus was not present in any of the oak material tested, and typical symptoms of the disease were lacking.

The disease of maples in which bronzed flags develop from foliage was not so much in evidence during the past year as in some previous years.

A disease of mockorange (*Philadelphus* spp.) continues to attract wide attention throughout Massachusetts. The disease is characterized by unsightly dead stalks which may be removed by pruning. Older shrubs can stand pruning of all affected stalks without being seriously disfigured. A fungus was found on the bark of dead stalks, but proof of its pathogenicity is lacking.

Numerous fungi were isolated from elms, but aside from the Dutch elm disease fungus (*Ceratostomella ulmi*), *Verticillium* sp. and *Cephalosporium* sp. were most common. Both of these fungi cause wilt diseases.

Other tree troubles diagnosed by field inspection or by laboratory culture and examination included the following uncommon and interesting diseases or fungus organisms:

On Catalpa — *Verticillium* wilt.

On Sugarmaple — *Steganosporium* sp. isolated from several maples probably weakened by drought.

On Elm — Several isolations of *Acrostalagamus* sp. and *Sporotrichum* sp. from twig samples tested for Dutch elm disease.

On Birch — *Coryneum disciforme* isolated from wilted branches of gray birch.

On Butternut — *Melanconis juglandis* associated with dieback of twigs and branches.

Rapid developments in the field of herbicides have encouraged widespread programs for the eradication of noxious plants, especially poison ivy at the base of trees and along highways. During the past two years vegetable crops in adjacent fields were seriously damaged because of the presence of a highly volatile ester in the herbicide. Herbicides should be selected carefully, therefore, to avoid a highly volatile ester in favor of a low volatile ester. In this way, the herbicide material will not be carried so readily in air currents over the surface of the ground into areas out of bounds for treatment.

**The Dutch Elm Disease.** (M. A. McKenzie, D. H. Marsden, W. E. Tomlinson, Jr., P. L. Rusden, R. L. Coffin, J. G. Moline.) From July 1, 1950 to June 30, 1951, the Dutch elm disease was found in 27 additional towns, making a cumulative total of 210 since the disease was first known here (1941, Alford, Berkshire County). In laboratory studies, by means of tissue plantings in artificial culture media, the disease fungus, *Ceratostomella ulmi* (Schwarz) Buisman, has been isolated from 8996 trees in 11 of the 12 counties on the mainland; Barnstable, Dukes, and Nantucket were reported as disease-free at present.

With present knowledge, practical restriction of Dutch elm disease rests principally upon (1) early discovery of diseased trees and prompt action in their removal and burning, and (2) a general sanitation program to eliminate elm bark beetles, the principal vectors of the disease fungus. In fact, research indicates also that the greatest handicap in control is delay in applying practices of sanitation. Therefore, delay in detecting diseased trees is a serious blow to reasonable control.

Better methods of control await further research which is now stymied and lapsed through lack of funds. On the basis of limited studies, the serious interruption of research on pruning diseased trees had delayed development of techniques and procedures which, if ready for application now, might save cities and towns thousands of dollars annually and hundreds of elm trees.

Likewise, on the basis of research there is every reason to believe that restriction or practical control of Dutch elm is possible in every community. The immediate cost is more reasonable than the postponed cost would be, but disease restriction requires action in detecting and removing, timed properly and not at the convenience of other work. This applies equally whether there is an accumulation of diseased trees or a new outbreak of the disease. This compulsion feature of control is, of course, unpopular and therefore delay may be expected in acceptance of it. But spread of the disease is uncompromising, and limited funds apparently saved in short-sighted economy will be required many times over for removal of dead trees, which become hazards to life and property, at a time when removal contributes in no way to disease control.

**The Pruning of Elms Affected with Dutch Elm Disease.** (D. H. Marsden.) The efficacy of pruning as a method of saving elms infected with Dutch elm disease was tested on a small scale in the Summer of 1950. In a scouting program, elms having only a small amount of wilt were pruned back severely at time of discovery, or at most within 24 hours. The proximal limits of discoloration in the pruned branches were determined for record, and tissue plantings from affected twigs were made in artificial culture media to determine the cause of the wilt in each case.

Twenty-one elms were operated on in this manner. Of these, 16 were infected with the Dutch elm disease fungus, *Ceratostomella ulmi*, two with *Cephalosporium* sp., one with *Verticillium* sp., one with bacteria, and one yielded no organism in culture. Two of the trees with Dutch elm disease were subsequently removed when further wilting occurred throughout the crown. On June 6, 1951, no further spread of the disease was apparent in 12 of the trees affected by Dutch elm disease. The remaining two trees were not observed.

The pruning experiment is being continued in 1951 with the tree wardens of several towns cooperating. It is already apparent that early detection of disease symptoms and prompt pruning out of affected parts of trees are essential if a diseased tree is to be saved. Spread of the infection to the trunk of a tree and thence to other parts of the crown precludes eradication of the disease by pruning.

**The Toxicity of Various Tree Wound Dressings to the Dutch Elm Disease Fungus.** (D. H. Marsden.) A number of proprietary compounds used commonly as tree wound dressings were tested to determine their toxic effect on the spores of the Dutch elm disease fungus, *Ceratostomella ulmi*. It was found that white lead paint, spar varnish, a penetrating wood-sealing compound, asphaltum, and asphalt-base tree wound paints failed to kill the spores of *C. ulmi* during periods of contact ranging from 1 to 11 days. White shellac, Bordeaux paint, a natural latex compound, and tree wound paints containing wood creosote oils killed the fungus spores after one-day contact. Also, the addition of 25 percent by volume of shellac to the nontoxic paints rendered them toxic to *C. ulmi* spores. Thus the possibility of the inoculation of elms with *C. ulmi* through wound dressings was verified, although no actual occurrence of disease spread in this manner has been found in trees.

**Wind- and Ice-Storm-Damage to Trees in 1950.** (M. A. McKenzie.) The early reports of the Massachusetts Agricultural Experiment Station and many other publications devoted extensive space to the subject of damage to trees from ice storms. The damage is often picturesque, spectacular, and expensive.

In the Connecticut Valley in Massachusetts, the windstorm of November 25 and the ice storm of December 29 afforded a rare opportunity to observe ice damage almost simultaneously with wind damage in the same plantation of trees. At the University, in the experimental plantation of elms about 20 years old, the fury of the windstorm shattered trees of a certain species of elm rendering them apparently unsuited for further research work. After clearing the plot, however, there was hope that individual trees of the species might be salvaged. This particular hope was short-lived because the ice storm wrought added havoc on remaining similar trees.

The most interesting observation was that *Ulmus pumila*, a rapid growing species of elm, somewhat resistant to Dutch elm disease, was most severely damaged by wind and ice.

Wood of this particular tree is characteristically more brittle than that of most elms. In contrast to many trees, the brittle branches snap readily instead of swaying or drooping. Apparently, the brittle character of the wood is the decisive one when this tree is exposed to either wind or ice. A live twig of American elm (*Ulmus americana*), for example, will withstand excessive bending, whereas one of *U. pumila* snaps.

This report is not intended to eliminate *U. pumila* from appropriate planting. Certain features of the experimental plot are not prevalent under all conditions. But where brittleness of the species might cause damage, selection of other trees may be a wiser choice for planting.



## DEPARTMENT OF VETERINARY SCIENCE

K. L. Bullis in Charge

**Poultry Disease Control Service.** (H. Van Roekel, G. H. Snoeyenbos, G. P. Faddoul, O. S. Flint, M. K. Clarke, O. M. Olesiuk, C. D. Brandt, B. A. Bachman, G. W. Fellows, and H. A. Peck.)

**Pullorum Disease Eradication.** Pullorum disease testing continues to be of great value to the Massachusetts poultry industry. During the 1950 and 1951 testing season a total of 556 chicken, turkey, and pheasant flocks were tested. The number of samples tested was 1,427,691 (1,394,192 from chickens and 33,499 from fowl other than chickens). The percentage of positive tests among chicken samples, representing 98.57 percent of all chickens tested, was 0.05. The percentage of "breaks" was 1.57. A total of 442 nonreacting chicken flocks was identified. Only six flocks were classified as positive at the end of the season.

The establishment and maintenance of pullorum-free flocks through effective testing and preventive measures have enabled flock owners to reduce the losses from pullorum disease to a minimum.

**Salmonella Pullorum Studies.** A nationwide survey of antigenic forms of *S. pullorum* was conducted for the purpose of securing antigenically complete forms which could be used for producing a superior testing antigen. Such a strain was found which, so far as is known, exhibits all the anticipated antigenic characteristics. Work is being continued to evaluate this antigen further.

This survey also indicated the relative incidence of variant forms of pullorum in the different states. A very wide variation of incidence was found. This incidence appeared to be closely associated with the efficiency of control methods used in each state. It was previously thought that the whole blood test was of primary importance in allowing the development of variant infection. Our results indicate rather, that multiple factors associated with control methods are of great importance in controlling variant infection.

**Diagnostic Service.** In the control and prevention of poultry diseases the diagnostic service is of inestimable value to the poultry industry in Massachusetts. Two laboratories located at Amherst and Waltham, respectively, are in operation in the state. Through their facilities the causes of the disease losses have been identified, enabling the flock owner to institute effective corrective measures.

During the 1950 calendar year, 6,410 specimens were received in 1,269 consignments of which 935 were delivered to the Amherst laboratory in person. The specimens included 5,945 chickens, 308 turkeys, 27 eggs, 19 canine feces, 17 chinchillas, 14 swine, 11 each of pigeons and pheasants, 10 each of bovine and mink, 5 rabbits, 4 each of canaries, ducks and sheep, 3 each of bovine feces, deer fetuses, geese and ruffed grouse, 2 each of dogs and foxes, and 1 each of goat, muskrat, quail, swan and woodcock.

Respiratory infections, discussed in another section, represented the most common diagnoses in chickens. Fowl paralysis (115), coccidiosis (89), keratoconjunctivitis (39), epidemic tremor (27) and so-called blue comb (27) represented other frequent diagnoses. Fowl cholera was diagnosed in 18 and fowl typhoid in 14 cases. The incidence of both

diseases was lower than in 1949, but that of fowl typhoid was significantly lower. Neither of the two most severely affected communities in 1949 had outbreaks in 1950. Avian tuberculosis was identified in 3 flocks.

Pullorum disease (2) and paratyphoid (1) continued to be uncommon diagnoses among turkeys. Fowl cholera (4) and swine erysipelas (3) appeared to be continuing as important problems. An outbreak that appeared to be typical nutritional encephalomalacia, as observed in chicks, was seen for the first time in poults. *Diplococcium* sp., identified by the Communicable Disease Center, Chamblee, Georgia, was recovered from the cerebellums of one lot of poults showing symptoms of a nervous disorder.

The Waltham Laboratory was officially opened for service on October 2, 1950. During the last three months of the calendar year of 1950, 1,295 specimens were received in 243 consignments of which 241 were delivered in person. The specimens included 1,239 chickens, 54 turkeys, and 1 each of geese and chinchilla. Lymphocytoma (35), capillariasis (29), Newcastle disease (16), ascariasis (16), and fowl paralysis (13) were the five chicken diseases encountered most frequently. Respiratory infections were also observed frequently among the cases submitted.

*Infectious Bronchitis Control.* Respiratory infections are of great economic concern to the Massachusetts poultry industry. A concerted effort has been made to reduce the losses from infectious bronchitis through an immunization program. During 1950, a total of 1,103 flocks was enrolled in the bronchitis control program. In general, the results have been very satisfactory in preventing natural outbreaks of the disease in immunized flocks. Modifications in the method of production have facilitated greatly the yield of the virus and improved the quality of the immunizing agent. This program has permitted flock owners to control infectious bronchitis thus preventing serious losses from the disease.

A total of 96 cases of respiratory disease was subjected to virus isolation by the embryo method. The following viruses were isolated: Newcastle disease 21; infectious bronchitis 18, of which 4 represented "breaks" following inoculation; 3 represented flocks manifesting a prolonged course of symptoms following inoculation, and in 1 both Newcastle disease and infectious bronchitis viruses were isolated; chronic respiratory disease agent, 20; infectious sinusitis agent, 2 turkey flocks; and laryngotracheitis, 1. Virus was not isolated from 35 cases, 13 of which were suspicious of being chronic respiratory disease.

During 1950, a total of 255 flocks was tested for infectious bronchitis. The diagnoses for the flocks were as follows: 202 immune, 20 susceptible, 15 questionable, and 15 had both susceptible and immune birds on the premises. Using the hemagglutination-inhibition test, 504 flocks were tested for Newcastle disease. The results were as follows: 200 immune, 229 susceptible, 7 questionable, and 68 had both susceptible and immune birds on the premises.

**Immunity Studies on Newcastle Disease.** (S. B. Hitchner, G. Reising and H. Van Roekel.) Previous studies on the effectiveness of vaccines in protecting chickens against Newcastle disease have indicated all vaccines to date have their limitations in insuring positive protection

against the disease. Investigations are being carried out to determine the factors which influence the effectiveness of the various vaccines, and to study methods by which the efficiency of vaccination against Newcastle disease may be increased.

The greater portion of these studies have dealt with the intranasal vaccine which is primarily used in the vaccination of baby chicks. Because of the low virulence of the virus used in this vaccine, it has been found that to protect the chicks each chick must receive many times the number of virus particles which it takes to infect an embryonating egg. Since the disease does not readily spread from chick to chick, careful administration of the vaccine to each chick is necessary to give protection.

Investigation of the outbreaks of Newcastle disease among vaccinated flocks and studies on the virus strains isolated from such outbreaks have not revealed any variant strains which differ antigenically from the intranasal vaccine strain. Therefore, the evidence would indicate incomplete flock immunity as the cause of outbreaks in vaccinated flocks, rather than new field strains of virus against which the intranasal vaccine will not protect.

Tests are under way to explore the possibility of immunizing chicks by spraying them with the same virus currently used in the intranasal vaccine. This method of application does not appear applicable in day-old chicks because it causes too severe a reaction. Results have been very favorable, however, in birds four weeks of age or older. Vaccination by atomization is done in the houses and thereby eliminates the labor of catching the birds and handling them individually. The immunity reactions in the flocks vaccinated by this method are being followed, and, if the results continue as favorably as in the past, there is a possibility that this method can be used for initial flock vaccination and revaccination to maintain the flock immunity at a higher level than has been possible in the past.

**Mastitis Testing Laboratory.** (W. K. Harris and I. M. Reynolds.) During the fiscal year of 1950 to 1951, a total of 37,580 milk samples was tested. Of this number, 19,223 were from 21 State Institution herds, 1,178 from the University Farm Department herd, and 17,179 from 182 private herds. Included in the latter were 307 samples from two county agricultural school herds, 15 from four goat herds, and 3,984 from ten demonstration herds. In addition to the total number of samples tested, 52 were received in a condition unsuitable for testing.

Three of the State Institution herds were dispersed during the year. The percentage of *Str. agalactiae*-infected cows in the remaining 18 herds has increased slightly to 13.4, although nine of the herds are now free from the infection. Field reports from a number of these herds indicate that average milk production per cow has increased over a two-year period between 870 and 3,374 pounds. In large part this is credited to better mastitis control.

The University Farm Department herd has remained free from *Str. agalactiae* infection for more than three years.

Studies are being made to reduce the amount of work and testing time required to obtain accurate results.

A number of herds have been seriously troubled with pseudomonas



udder infections which have not responded favorably to treatment.

The number of herds testing more than once during the year is about double that of 1949 to 1950. This reflects the increased use of the diagnostic service by the dairymen and parallels the reduced mastitis in the herds.

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## PUBLICATIONS

### Bulletins

- 459 Annual Report for the Fiscal Year Ending June 30, 1950. 92 pp. September 1950.

### Control Bulletins

- 144 Inspection of Commercial Feedstuffs. By Feed Control Service Staff. 27 pp. May 1950.
- 145 Inspection of Commercial Fertilizers and Agricultural Lime Products. By Fertilizer Control Service Staff. 15 pp. July 1950.
- 146 Thirtieth Annual Report of Pullorum Disease Eradication in Massachusetts. By the Poultry Disease Control Laboratory. 11 pp. July 1950.
- 147 Seed Inspection. By Seed Control Service Staff. 29 pp. November 1950.

### Meteorological Bulletins

- 733-748 Monthly reports of daily weather records, including monthly and annual summaries. H. N. Stapleton and E. F. Cox. 4 pp. each.

### Reports of Investigations in Journals

#### NUMBERED CONTRIBUTIONS

- 697 Cancelled.
- 706 Cancelled.
- 709 Phenotypic and genotypic selection of breeding females. F. A. Hays. Poultry Sci. 28 (3):467-469. May 1949.
- 714 *Escherichia coli* in digested sludge. J. E. Fuller and W. Litsky. Sewage and Indus. Wastes. 22 (7):853-859. July 1950.
- 715 Vitamin and amino acid content of processed chicken meat products. R. Millares and C. R. Fellers. Food Res. 14 (2):131-143. 1949.
- 729 Effect of added riboflavin upon the permanency of ascorbic acid in raw cow milk. A. D. Holmes. Jour. Milk and Food Tech. 13 (4):206-208. August 1950.
- 743 Recent advances in the microbiological methods for the determination of vitamins and amino acids. N. W. Desrosier. Jour. Milk and Food Tech. 13 (4):209-214. July-Aug. 1950.
- 744 Chloroplast pigments in relation to magnesium deficiency. D. A. Hinkle and W. S. Eisenmenger. Soil Sci. 70 (3):213-220. September 1950.

- 747 Weeding corn with chemicals II. W. H. Lachman. Amer. Soc. Hort. Sci. Proc. 56:279-282. December 1950.
- 748 Mineral content of tomatoes grown with different types of mulches. A. D. Holmes, R. T. Wetherbee, C. T. Smith, and W. H. Lachman. Food Tech. 4 (7):10. 1950.
- 751 Anther Smut of Carnation. J. L. Spencer and H. E. White. Phytopathology. 41 (3):291-299. March 1951.
- 754 Some attempts to thin apples with naphthaleneacetic acid type materials after calyx. F. W. Southwick and W. D. Weeks. Amer. Soc. Hort. Sci. Proc. 56:70-75. 1950.
- 755 Residual effects of heavy mulching in a bearing apple orchard on soil nutrients. W. D. Weeks, C. T. Smith, and M. Drake. Amer. Soc. Hort. Sci. Proc. 56:1-4. 1950.
- 756 Thermal inactivation of fruit enzymes in relation to processed products. W. B. Esselen, Jr. The Glass Packer. 29 (7):483-485, 496, 598, 500. July 1950.
- 757 The sugars of the hemicelluloses of cornstalks. E. Bennett. Plant Phys. 26 (1):182-185. January 1951.
- 759 Studies on the peroxidase in pickles and pears. E. A. Nebesky, W. B. Esselen, Jr., and C. R. Fellers. Food Tech. 5 (3):110-113. 1951.
- 760 Heat transfer in commercial glass containers during thermal processing. I. S. Fagerson and W. B. Esselen, Jr. Food Tech. 4 (10):411-415. 1950.
- 761 Effect of methods of irrigating cranberry bogs on water table and soil moisture tension. F. B. Chandler. Amer. Soc. Hort. Sci. 57:65-72. 1951.
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**Erratum:**    *Top of page 42 should read:*

DEPARTMENT OF OLERICULTURE

Grant B. Snyder in Charge

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MASSACHUSETTS  
AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 467

MARCH 1953

## Annual Report

For the Fiscal Year Ending June 30, 1952

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The main purpose of this report is to provide an opportunity for presenting in published form recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

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BROWN, HARRY DUNLAP, Billerica	1954
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CROWLEY, DENIS M., Boston	1959

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# FINANCIAL STATEMENT, 1951-52, UNIVERSITY OF MASSACHUSETTS, AGRICULTURAL EXPERIMENT STATION

	Hatch	Adams	Purnell	Bankhead-Jones	Research & Marketing 9b1-2	Regional Research 9b-3	Non-Federal Funds	Total
RECEIPTS								
Received from								
U. S. Treasury	\$15,000.00	\$15,000.00	\$60,000.00	\$36,698.19	\$42,673.96	\$11,569.25	\$442,213.45	\$180,941.40
State appropriation							47,778.17	442,213.45
Special							21,178.65	47,778.17
Balance forward								21,178.65
Total receipts	\$15,000.00	\$15,000.00	\$60,000.00	\$36,698.19	\$42,673.96	\$11,569.25	\$511,170.27	\$692,111.67
DISBURSEMENTS								
Personal service	\$ 7,453.27	\$15,000.00	\$48,943.09	\$27,925.48	\$24,057.49	\$ 8,000.00	\$422,340.77	\$553,720.10
Travel	733.58		1,154.46	413.86	2,384.35		8,648.04	13,334.29
Transportation of things	7.95		46.95	4.58	33.94		1,043.66	1,137.08
Communication service							5,064.98	5,064.98
Rents and utility services							1,395.60	1,395.60
Printing and binding					143.70	1,069.25	2,310.97	3,523.92
Other contractual services	305.00		69.28		1,259.36	2,500.00	5,753.35	9,886.99
Supplies and materials	2,090.15		4,680.04	3,025.19	9,190.13		23,646.31	42,631.82
Equipment	4,410.05		5,106.18	5,329.08	5,604.99		10,143.67	30,593.97
Balance Forward							30,822.92	30,822.92
Total disbursements	\$15,000.00	\$15,000.00	\$60,000.00	\$36,698.19	\$42,673.96	\$11,569.25	\$511,170.27	\$692,111.67

## DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. LINDSEY IN CHARGE

**Effects of Price Support on Potato Marketing in Massachusetts.** Within limits set by competing markets and the seasonal nature of potato production in the United States, the demand of Massachusetts markets for potatoes establishes a pattern of receipts that is fairly static under competitive conditions. Changes in the pattern can occur when large areas of new land are brought into commercial production, or when old land goes out of cultivation. Such changes tend to be gradual, however, and their progress can be traced.

This study has been concerned with analyzing the effect of a quasi-competitive supply-demand situation on the pattern of potato marketing in Massachusetts. The period under investigation has been the crop years 1943 through 1950, when support prices were a major influence in national potato production and marketing. During this period, total production of major areas supplying the market reached high levels and remained high even after acreage allotments were set up to help relieve burdensome surpluses. Certain areas, such as California, Long Island, and Canada, increased their production and their proportions of the market supply. Other areas, such as Maine, Massachusetts, and New Jersey, also increased production but reduced their proportions of the supply in certain stages of the marketing year. The effect of these movements was a changed seasonal pattern of receipts of potatoes at local markets. Areas with reduced proportions of the local supply also showed a downward trend in total commercial sales less government purchases for support.

By 1948, compared to former years, Massachusetts was marketing a larger part of its crop in the winter and, consequently, was using existing and new winter storage capacity to a greater extent. This shift was partly a response to a guaranteed seasonal price rise and partly to competitive pressures. The increased lateness of the local crop and the changed seasonality of out-of-state receipts caused the local early crop to be marketed in a shorter interval than formerly. Increased lateness (resulting directly from greater use of late varieties) has also brought the local grower into closer competition with the leading late crop supplier, Maine.

Analysis of the marketing of the 1950 local crop showed that growers used 23 different outlets, including direct and indirect sales, for price support. Price support was available to eligible growers only during the latter part of the season, but growers in general were concerned with recovering and maintaining competitive outlets. Marketing of the 1951 crop was not subject to price support, and the smallest acreage on record was planted in Massachusetts.

—A. H. Lindsey and R. A. Fitzpatrick

**Pricing Eggs on the Boston Market.** Daily price series on shell eggs for Boston, New York, and Chicago were prepared from the daily reports of the Boston Fruit and Produce Exchange for 1946 to 1948, inclusive, and 1951. These filled out the post O. P. A. period and permitted more adequate analysis and consideration of factors associated with egg pricing in the Boston Market. The relationship of the Boston Market to the New York and Chicago markets as indicated by analysis for the period 1949-50 was borne out over the longer period.

The nature of the price-movements in the New York and Boston markets of comparable grades of eggs were analyzed with the particular objective of determining the nature and extent of the New York influence on Boston. Price changes in both markets were characterized by periodicity or swings—some upward, some downward. Curiously enough, the number of such periods was about the same, 16, 16, and 18 in each of the three years. Most of the periods were of comparatively short duration lasting for two to ten market days. What might be described as long swings accounted for only 18.8 percent of the periods. The longest sustained upward movement extended over 43 market days from Friday, May 26, through Thursday, July 27, 1950.

Two indications of the relationship were considered—timing and price change in cents per dozen in both markets. Twenty-nine of the 50 periods identified began and 26 of the periods ended on the same day in both markets. The aggregate price change during 17 of the periods was of the same amount in both New York and Boston and within one cent per dozen in 15 of them.

The periodic price movements were quite clearly defined in 1949 and 1950, and there were a few in 1951 which were unmistakable. The periods did not coincide so well, however, for Boston and New York in 1951, nor were the price movements so nearly alike. During the two earlier years, the price movements were uniform or for the most part, over the period within one cent of each other. By 1951 the swings, although in the same direction, tended to overrun or stop short with more frequency. The market(s) in 1951 were subject to more frequent changes and to periods that could be described only as "mixed."

—*A. A. Brown, R. W. Brundage, and Alden C. Manchester*

**Possible Economies in the Marketing of Eggs.** This study is part of a more inclusive one concerned with the supply areas and markets for eggs produced on New England poultry farms. The area-wide research is drawing extensively on data from secondary sources especially with regard to smaller markets. The work in Northampton is designed to supplement this.

Two hundred and thirty-five householders were interviewed during May and September regarding their purchases and use of eggs. The retailers, farmers, and other sellers from whom these purchases were made were also interviewed.

Tabulation and analysis of the data are underway, and only limited, tentative results can be reported. Two items warrant mention. Direct purchase from farmers accounted for slightly more than half (51.1 percent) of the eggs bought by this group of householders. Considering the location of the city and the agriculture of the surrounding areas, this percentage is lower than might be expected.



The volume bought from stores, independents and chains combined, amounted to 32.1 percent of total consumer purchases. Some stores received eggs directly from nearby farms; others received them from sources in Boston, Springfield, and Hartford. Eggs from poultry farms in the area adjacent to Northampton, meanwhile, were being shipped to Springfield. The extent of the cross-hauling and its implications await completion of the analysis.

—*Alfred A. Brown, V. J. Pierce, and R. W. Brundage*

**Intermarket Milk Price Relationships.** Price differences between Boston and five secondary markets, Springfield, Worcester, Lowell-Lawrence, Fall River, and New Bedford, were determined on an annual average basis for a 16-year period from 1935 to 1950, for Class I, Class II, and producer milk. In addition, the milksheds for eight marketing areas, involving about 4500 producers, were determined on a town basis.

Comparison of actual, with the theoretic supply areas developed in the Northeast regional study indicates that generally the markets studied receive their supplies from the most economical source available.

Analysis indicates that producer prices in secondary markets are higher than those in Boston, in part because of higher Class I prices, but primarily because of higher percentage Class I utilization. Higher Class I utilization, at least in part, appears to result from less economical handling costs of Class II in the secondaries because of periodic fluid demands for the nearby supplies, and generally smaller scale manufacturing operations. Only a small part of the differences are attributable to location, that is, location relative to competing markets, and varying hauling cost distances.

The level of Class I, in relation to Class II prices, has varied considerably from period to period, with the result that reactions appear to develop to much wider or narrower spreads. A change in the range between Class I and Class II appears generally to be followed by production-consumption responses to the relative high or low Class I price. Therefore, although the precise speed and degree of supply-demand response is not known, there seems to be no doubt that the effects of a relatively high or low Class I price is moderated to an important degree by resulting variations in the percentage Class I utilization. Since Boston carries a higher percentage of Class II milk, wider spreads between class prices result in wider differences in producer prices between Boston and the secondary markets.

An increase in the range between Class I and Class II prices also increases potential price pressure from nonregulated and New York 1-C milk. The quantity of Class II can be regulated through pricing of Class I milk. Class I pricing in Boston is particularly important because it forms the standard of pricing in whole or in part in most of New England.

—*H. G. Spindler and V. J. Pierce*

**Production Adjustments on Representative Massachusetts Farms.** The project was handicapped by a lack of personnel. No fill-in for the project leader was made during his leave of absence for a year. Dr.

Jarvesoo left the project after three months, and Mr. Vetterling served on the project for only a few weeks.

Over 50 Massachusetts farms previously selected for study were not dormant, however, during the year. Several of these were visited on the return of the project leader, and current adjustments were reviewed in terms of their effect on the whole farm business.

A comparative analysis of changes in production organization and labor efficiency on Bristol, Essex, Franklin, and Hampshire County farms from 1945 to 1950 has been made. The study included 183 farms in Bristol County; 86 in Essex County; 47 in Franklin County; and 66 in Hampshire County. County data on changes on identical farms over the five-year period were limited. The larger and more representative sample from Bristol County gives the most reliable results.

The size of the Bristol County farms, measured in terms of productive man work units or man days (PMWU) increased 7.7 percent from 1945 to 1950. Full-time workers per farm declined slightly from 2.56 in 1945 to 2.4 in 1950. The result was an increase of 16.5 percent in labor accomplishment per man. In 1945, dairy production units made up 43 percent, and poultry units 32 percent, of the county total. By 1950, poultry units including turkeys were 40 percent, and dairy units 37 percent, of county totals. Potato, sweet corn, and tomato enterprises decreased in importance during the same period, whereas lettuce and certain other vegetables increased in acreage.

All types of specialized Bristol County farms increased their labor efficiency per man during the five-year period:

- 14 poultry farms by 17 percent
- 24 vegetable farms by 11 percent
- 68 diversified farms by 29 percent
- 77 dairy farms by 3.5 percent

The dairy farms decreased in size from 1945 to 1950 by 9 percent; their labor force decreased by 12 percent during the same period. The result was an increase of 10 percent in cows per man, from 12.3 to 13.5

The Essex County farms studied showed a slight reduction in size of farm with some increase in labor force. The result was an 11 percent drop in labor efficiency. The reduction in vegetable acreage was not offset by increases in poultry enterprises. Cow numbers remained stable. The farms of Franklin and Hampshire Counties were alike with almost no changes in production organization or labor efficiency during the five-year period. Labor efficiency per farm changed less than 1.5 percent in either county.

The findings have been made available to the respective county agents who have used them in their extension work. The diversity in production changes by counties would make a state summary of trends rather meaningless.

The case analyses and research work of production changes formed the basis for many articles published during the year (see Miscellaneous Contributions, page 94)

—Bradford D. Crossmon, Elmar Jarvesoo and Philip Vetterling

**Study of Farm Real Estate Taxation, Methods of Taxation Reform, and the Effect of Such Measures on Farm Income.** With a view toward devising objective measures of valuation for tax purposes, a group of dairy farms in one town was selected for analysis of land use capability, as defined by the Soil Conservation Service. Among these farms, it was found (as expected) that marked differences existed in the proportions of land in the various classes, although all the farms were dairy farms and located in the same town.

In two farms of comparable size, Class I (very good) land ranged from 2 to 26 acres. In two other comparable farms, Class VII (very poor) land ranged from 0 to 56 acres. In the group of farms as a whole, Class I land was 10 percent, and Class VII land 24 percent, of the total acreage. Further analysis revealed a wide variation in the kinds of soil in the farms.

The data on land use capability were then analyzed in terms of assessed valuations for tax purposes as recorded in the assessors' lists. It was found that the average valuation per acre did not uniformly reflect the amounts of poor or good land in a given farm. For example, in three farms, whose percentage of Classes I and II were 81, 19, and 40 percent, the average valuation per acre was \$39, \$54, and \$90, respectively. Such evidence indicates that the capability of the land for crop and livestock production is not observably related to the valuation for tax purposes.

—A. A. Brown and R. A. Fitzpatrick

## DEPARTMENT OF AGRICULTURAL ENGINEERING

H. N. STAPLETON IN CHARGE

### Animal Shelters and Farm Crop Storages.

#### *Improvement of Poultry House Ventilation.*

During the summer the multipoint temperature recording instrument was used in evaluating the effectiveness of aluminum roofing in reducing the solar radiation input to a building. Tests indicated that aluminum roofing is equivalent to four inches of shavings in the reduction of solar radiation.

Evaluating of the data collected during the winter of 1950-51 indicates that the dew point temperature on the south side of a building is approximately equal or slightly lower than the dew point temperature on the north side of the building. The dry bulb temperature on the south side of a building was found to be as much as 20 degrees higher than that on the north side of the building because of solar heat. If intake air for the poultry house comes from the south side of the building, during the part of the day when the dry bulb temperature on the south side is above that on the north, excessive ventilation would be permissible for the control of litter moisture.

#### *Investigations to Improve Tobacco Curing*

Cooperating with a tobacco farmer, the chief investigation during the season of 1951 concerned the use of oil burners in tobacco sheds.



On one farm, five sheds of tobacco were cured, four with experimental oil burners. The dry bulb—dew point multiple record instrument indicated that a very uniform temperature could be held between the top of the first tier and the top of the shed. The temperature varied considerably between the ground and the top of the first tier and also through the space between the burners. Because of the large heating capacity of these burners, only 14 could be used in a shed 30 feet wide by 180 feet long. The necessary wide spacing of burners left unheated areas in the first tier in which some spoilage developed.

Open flame oil burners can be used in curing tobacco without imparting an oil odor to the tobacco.

The fuel cost of oil is about one-third that calculated for charcoal or gas of equivalent gross Btu.

—*H. N. Stapleton and Earle F. Cox.*

**Investigations on Mechanizing Cranberry Production.** Development of a hydraulic sanding device has been completed, and a limited amount of experimental sanding has been done with it. The results to date indicate that a rate of 20 cubic yards per hour can be sustained with 400 feet line on the sander and that as this distance is decreased, the rate can be increased to 30 cubic yards per hour. With four hose-men on the bog and one man at the sand box, it is possible to sand an acre of bog in three hours operating time, assuming that the rate of coverage will not exceed 80 cubic yards per acre.

A hydraulic ditch-cleaning device has been developed and has undergone preliminary tests. This device is mounted on the general purpose tractor developed for use in the cranberry industry. A series of disks powered by an auxiliary engine operates in the ditch to loosen the accumulated material and to chop weeds and grass. From the chopper the material is fed back into a dredge snout, which forms the intake of the suction line to the trash pump. The effluent is discharged from the trash pump onto the shore of the bog.

Laboratory testing on commercially available nozzles is almost complete. In addition to the tests on the nozzles, a test was conducted on a machine using a system of centrifugal breakdown. This machine gave a more uniform droplet size and offered better control of the droplet size than the commercially available nozzles.

—*Earle F. Cox.*

**Barn Hay-Drying.** The testing of fans with suitable efficiency for use with forage drying without supplemental heat has been completed, and the data are being evaluated. A plenum tunnel rather than test code procedures was used to evaluate more accurately the fan performance under similar conditions of application. Three fans were tested: a 2-blade, 54-inch diameter; a 2-blade, 48-inch diameter; and a 6-blade, 48-inch diameter. Appropriate efficiency curves for the 5-Hp motor had previously been determined in the laboratories of the Department of Electrical Engineering. With the fans several combinations of air inlet and air outlet modifications were tested. Tests were also conducted to determine the effect of the cleanliness of the fan blades as well as the effect of blade tip-mounting ring clearances.

The results indicate that the blades should be maintained in a clean condition, and that as much as 10 percent reduction in air delivery may be expected from soiled blades. A decrease of as much as 40 percent in air volume may be expected with some stock commercial fans unless the clearance between the blade tip and the mounting ring is reduced. Fan efficiency increases with the addition of a cylindrical discharge tube of length equal to the fan diameter; and modification of the discharge tube to a slightly diverging section provides a further slight, increase in fan efficiency.

In the search for simple moisture testing equipment, a new model tester using infra-red heat has been compared with the Brown-Duval method. It was found that the "standard error" of the infra-red tester is so indefinite that it is considered unsatisfactory for rough field tests unless overnight operation is permitted.

—Earle F. Cox.

## DEPARTMENT OF AGRONOMY

W. G. COLBY IN CHARGE

**Relative Potassium Competition of Colonial Bent, Kentucky Blue Grass, and Smooth Brome-Grass When Grown With Ladino Clover.** Grasses with roots of different cation exchange capacity and Ladino clover were grown separately and in combination on a soil with a low level of exchangeable potassium. Cation exchange capacities of the plant roots were: colonial bent 16 me, Kentucky bluegrass 21 me, smooth brome 25 me, and Ladino clover 43 me (me = milliequivalents per 100 grams of dry roots). In theory, plant roots with low cation exchange capacity should adsorb relatively more K than roots of high cation exchange capacity when grown on soils with a low to medium level of available K. Likewise, when grown with Ladino clover or other legumes, grass roots with low cation exchange capacity should offer greater competition for K than grasses with roots of high cation exchange capacity. Relative differences of these plants in their feeding power for K at different levels of applied K were studied.

When the plant species were grown alone, the first increment of applied K produced an increase in both yield and percent K. In the first three cuttings the percent K in all plants was increased, but yields were not increased by the highest K application. However, this highest K application produced much greater Ladino clover yields in the fourth cutting.

Differences of these grasses in K compatibility when grown in combination with Ladino clover were investigated at different K treatments. Results indicated that plant species differ greatly in their feeding power for soil K. At the exchangeable K level (100 K<sub>2</sub>O pounds/acre) the relative uptake of K in the first cutting was bentgrass, 100; Kentucky bluegrass, 60; smooth brome-grass, 38; and Ladino clover, 29. The relative K uptake in three cuttings was bentgrass, 100; bluegrass, 72;

and Ladino clover, 40. These values agree well with the theory of cation adsorption based on relative cation exchange values of the plant roots.

In the Ladino clover-grass associations, bentgrass was by far the most serious K competitor and smooth brome was the least serious competitor. When 60 pounds of  $K_2O$  were applied before planting and again after the first cutting, the third cutting Ladino contained 0.54 percent K with bentgrass, 0.95 percent K with Kentucky bluegrass, and 1.07 percent K with smooth brome-grass. When 120 pounds  $K_2O$  were applied initially, the third cutting Ladino contained 0.54, 0.70, and 1.13 percent K, respectively, with bentgrass, Kentucky bluegrass, and smooth brome-grass.

Either delaying or splitting the K application to the Ladino-bentgrass association increased both yield and K uptake by the bent in both the second and third cuttings so that both yield and K uptake of Ladino were reduced in the second and third cuttings.

In contrast, splitting the 120-pound  $K_2O$  application in the Kentucky bluegrass-Ladino association greatly increased both yield and percent K in both the second and third cuttings of Ladino clover. When only 60 pounds of  $K_2O$  were applied, and that as a top-dressing after the first cutting to the bentgrass-Ladino association, the percent K in the second cutting was 0.74 in Ladino and 1.95 in bentgrass, but in the Kentucky bluegrass-Ladino the percent K was 0.92 in Ladino and 1.75 in bluegrass. When 120 pounds of  $K_2O$  were applied initially, the percent K in the second cutting was 0.94 in Ladino and 2.17 in bentgrass, but in Kentucky bluegrass-Ladino the percent K was 1.35 in Ladino and 1.75 in bluegrass. Although Kentucky bluegrass competed with the Ladino clover for K, this competition was much less than that by bentgrass.

Data from this and related experiments indicate that Ladino clover should contain at least 1.5 percent K for best production. Therefore, on a soil with a relatively low level of K it appears impossible to meet the K requirements of Ladino clover by moderate K fertilizer applications, when associated with bentgrass. These results emphasize the great importance of destroying the remnants of a bentgrass sod more completely by a smother crop or an intertilled crop before attempting to make a new seeding of Ladino clover.

—Bryce C. Gray, Mack Drake, and W. G. Colby in cooperation with the Departments of Chemistry and Agronomy.

**The Chemical Composition of Weeds and Their Companion Plants.** Studies initiated in 1950 on the chemical composition of weeds and their companion plants were continued in 1951. Grassland and arable land weeds were collected from typical farms in the Connecticut River Valley. Analyses were made for N, P, K, Ca, and Mg.

Cumulative data for two years indicate that weeds are important competitors with crop plants for essential nutrient elements. In grasslands, weeds with leafy, vegetative growth, such as *Taraxacum officinale*, *Plantago lanceolata*, *Asclepias syriaca*, and *Onoclea sensibilis*, were all high in nitrogen content. Almost all grassland and arable land weeds had a significantly higher phosphorus content than the associated culti-



vated plants. It would appear that many weeds are capable of utilizing forms of soil phosphorus not readily available to some cultural plants.

Many grassland weeds were high in potassium, indicating that along with the grasses, they are very strong competitors with legumes for available soil potassium. Some of the arable land weeds on heavily fertilized soils had very high concentrations of potassium. Purslane (*Portulaca oleracea*) from onion fields had 8.4 percent K, and chickweed (*Stellaria media*) from potato fields, had 8.3 percent K.

The calcium content of grassland weeds was about four times as great as that of timothy, and the magnesium content was about three times as great. The calcium and magnesium content of weeds compared favorably with that of red clover.

—Jonas Vengris, Mack Drake, W. G. Colby, and Joseph Bart.

**Raw Rock Phosphate Compared with Superphosphate as a Source of Phosphorus for Forage Plants.** In New England the present information on the relative availability of rock phosphate and superphosphate to grass-legume hay and pasture crops is inadequate. In 1949, a field experiment was started on Merrimac fine sandy loam near Amherst to compare the effect of rock phosphate and superphosphate on forage crop yields. The soil was limed to pH 6.7. The phosphate treatments consisted of 2000, 3000, and 4000 pounds of rock phosphate, 1000 and 2000 pounds of superphosphate, and a combination treatment of 1000 pounds of rock phosphate and 500 pounds of superphosphate. Alfalfa, timothy, and a mixture of Ladino and smooth brome-grass were the forage crops used to measure the response.

In the first two years of harvest, the yields from the timothy, alfalfa, and Ladino-brome treated with 2000 pounds of rock phosphate have compared favorably with the 1000-pound superphosphate treatment. The average yield for each harvest year for timothy was 9200 and 9380; for alfalfa, 6220 and 5940; and for Ladino-brome, 4730 and 4840 pounds of 15-percent moisture hay on the 2000-pound rock phosphate and 1000-pound superphosphate treatments, respectively. The phosphorus uptake for timothy for each harvest year was 13.0 and 14.0; for alfalfa, 11.5 and 11.9; and for Ladino-brome, 12.6 and 13.1 pounds of phosphorus on the 2000-pound rock phosphate and 1000-pound superphosphate treatments, respectively.

On the 1000-pound superphosphate treatment, the timothy, alfalfa, and Ladino-brome have removed in the first two harvest years 32, 27, and 30 percent, respectively, of the 200 pounds of  $P_2O_5$  supplied at the beginning of the experiment. Since no further additions of phosphate will be made, the relative performance of the three forage crops on the rock phosphate and superphosphate treatments is expected to change in the next two or three years.

—J. E. Steckel, Mack Drake, and T. A. Bertinsson.

**The Improvement of Control Measures for Diseases and Weeds in Tobacco Seedbeds.** Sufficient suitably sized, healthy plants to transplant and restock tobacco in the field in proper season are a requisite for the profitable production of tobacco. Good tobacco seedbeds are farmers' best assurance of having sufficient suitable tobacco plants.

It is the purpose of this project to improve farming practices in the production of tobacco seedbeds. The effects of certain very important operations in the preparation of seedbeds have been studied. These operations include the sterilization and fertilization of the seedbed soil, the working of the seedbed soil in the spring for seeding, and the rate of seeding. On the basis of the experimental results obtained, the following recommendations can be made safely:

1. Sterilize tobacco seedbed soil by some approved method.

Steam, methyl bromide, and chloropicrin, if used properly, are effective soil sterilizing agents. Chloropicrin must be used in the fall while the temperature of the soil is 60°F. or higher. Methyl bromide is best used in the fall when the temperature of the soil is 50°F. or higher. Although steaming of the soil can be done in the fall or in the spring, fall steaming is preferable.

Sterilization of seedbed soil reduces bed-rot diseases and improves the stand of seedlings and the later growth of plants. It gives good control of weeds and almost eliminates the necessity of hand-weeding. It has other beneficial effects as well.

2. Fertilize tobacco seedbed soil in the fall with some suitable organic fertilizer. Regular 6-3-6 tobacco fertilizer at the rate of 100 pounds per 1000 square feet of seedbed area applied in the fall usually supplies enough plant food to grow good tobacco seedlings in the following spring. Organic fertilizers applied in the fall will not retard the germination of tobacco seed nor the early growth of seedlings. If regular tobacco fertilizer is used in the fall, as suggested, the application of supplementary fertilizers in the spring before seeding will not be needed.

The results of experimental work show that a spring application of fertilizers very often impairs the germination of tobacco seed and retards the early growth of tobacco seedlings. Inorganic fertilizers, which are worse than organic fertilizers in this regard, when applied to tobacco seedbeds in the fall, do not supply enough nitrogen to grow tobacco plants satisfactorily in the following spring.

Fertilizer applied on tobacco seedbeds in the fall should be worked into the soil well before sterilizing is done.

3. In the preparation of seedbed soil in the spring for seeding, it is advisable to work the soil to a depth of not more than three to four inches, if the soil was fertilized and sterilized in the fall. This procedure will avoid bringing unsterilized earth and viable weed seeds to the surface of the seedbed. It will also avoid the formation of deep depressions in the soil after seeding has been done.

4. If tobacco seed germinates 90 percent or more, seed should be sown at the rate of approximately one ounce per 1000 square feet of seedbed. Heavier rates of seeding may produce spindly plants, which will not withstand transplanting well; higher rates of seeding are likely to produce squatty plants, which are difficult to transplant.

More detailed information about the results obtained from experimental work in the particular operations mentioned is contained in reports for 1949 to 1951, inclusive.

—C. V. Kightlinger.

**The Improvement of Havana Seed Tobacco.** It is the purpose of this project to improve Havana Seed tobacco and its production in Massachusetts.

One phase of the project concerns the breeding of new strains of Havana Seed tobacco that combine (1) high resistance to black root rot, wildfire, and common tobacco mosaic, with habits of growth and yielding capacities that are more acceptable to tobacco farmers than those of the older strains of tobacco and (2) the ability to produce tobacco leaf of type and quality that are more acceptable to cigar manufacturers than the older strains of tobacco. Another phase of the work is concerned with farming, improving the practices in preparing tobacco for harvesting, and in harvesting the crop itself.

Strains of Havana Seed tobacco more highly resistant to black root rot, and with more desirable habits of growth and yielding capacities, have been produced. These strains also have the capacity to produce tobacco leaf of better type and quality than the older strains of Havana Seed possessed or were capable of producing. The results of work done to determine the best heights at which to top plants of the black root rot resistant strains of Havana Seed and the proper stages of maturity to which the tobacco should be allowed to mature before it is harvested have improved farming practices for preparing tobacco for harvest. These improvements are responsible for better yields of tobacco and better quality of cured leaf. For detailed information about the acceptability of the black root rot strains of Havana Seed by farmers and by the tobacco trade in Massachusetts and resulting increased profits to the growers of Havana Seed in the State, readers are referred to the reports of 1949-51, inclusive.

Work is underway to breed strains of Havana Seed tobacco that will combine improvements in all the properties that have made the black root rot strains popular, with high resistance to wildfire and common tobacco mosaic. This undertaking has not been completed, but the results of the work to date are promising.

—C. V. Kightlinger.

### **The Capacity of Certain Soils Weathered from Different Rocks to Furnish Ions to Plants with Special Reference to Magnesium.**

Twenty-three species of plants grown on eight different soil series were collected. The soils, which had not been influenced by previous fertilization, were Dover, Suffield, Bernardston, Brookfield, Gloucester, Charlton, Merrimac, and Hinkley. With the exception of Merrimac and Hinkley, they were loams with silt and clay content of 24 to 54 percent. The average magnesium content of all plants grown on these loams was slightly more than .2 percent. The plants grown on the two sandy soils contained about .17 percent of magnesium; those on Dover soil averaged .257 percent; and those on Merrimac soil were the lowest in magnesium content.

This deficiency has been changed on numerous sandy areas.

It would seem that two main factors govern the availability of magnesium for plants: the presence of moderate amounts of silt and clay in the soil and the weathering of rocks containing an abundance of magnesium.



Plants growing on soils high in silt and clay were also found to be higher in calcium and potassium content than those on sandy soils.

—Walter S. Eisenmenger and Karol J. Kucinski.

### Weeds Found in Cultivated Field of the Connecticut Valley.

Although new chemical herbicides have recently created a new era in weed control, they are not a panacea. They are only tools, and their proper use with various crops must be based on a thorough knowledge of kinds of weeds to be found and the relative abundance of each kind for the important crops grown.

The weeds found in tobacco, onion, potato, and cornfields, were investigated in 1950 and 1951.

The important weed species found with various crops in the order of their relative frequency are listed below;

a. **Tobacco Fields:** *Digitaria sanguinalis*, *Echinochloa crusgalli*, *chenopodium album*, *Portulaca oleracea*, *Amaranthus retroflexus*, *Panicum capillare*, *Mollugo verticillata*, *Stellaria media*, and *Amaranthus albus*.

b. **Onion Fields:** *Digitaria sanguinalis*, *Portulaca oleracea*, *Echinochloa crusgalli*, *Amaranthus retroflexus*, *chenopodium album*, *Stellaria media*, *Amaranthus albus*, *Panicum capillare*, *Mollugo verticillata*, and *Polygonum pensylvanicum*.

c. **Potato Fields:** *Echinochloa crusgalli*, *Amaranthus retroflexus*, *chenopodium album*, *Digitaria sanguinalis*, *Polygonum pensylvanicum*, *Panicum capillare*, *Polygonum Persicaria*, *Portulaca oleracea*, *Ambrosia artemisiifolia*, and *Stellaria media*.

d. **Cornfields:** *Digitaria sanguinalis*; *chenopodium album*, *Amaranthus retroflexus*, *Polygonum pensylvanicum*, *Ambrosia artemisiifolia*, *Panicum capillare*, *Mollugo verticillata*, *Echinochloa crusgalli*, and *Portulaca oleracea*.

The weed flora in tobacco fields consisted of 39 species; in onion fields, 34; in potato fields, 55; and in cornfields, 66.

—Jonas Vengris.

**Control of Forage Crop Weeds in Massachusetts.** The forage crop is one of the most important crops grown in Massachusetts. Although weeds have always been present to a greater or lesser extent in most forage crop seedings, the weed problem has become much more serious during the past few years. Higher soil fertility levels and reduced acreages of corn and other cultivated crops in rotation are two important causes of this serious weed problem.

The objectives of weed control investigations include:

- Chemical weed control in new seedings of grass-legume mixtures
- The role and importance of seeding rates and nurse crop in the control of weeds in grass-legume mixtures.
- Pre-planting application of  $\text{CaCN}_2$  in controlling weeds in grass-legume seedings.

—Jonas Vengris, Wm. G. Colby, and Mack Drake.

**Breeding Corn for Grain Production in Massachusetts.** In 1951, 45 single crosses of Massachusetts 63 maturity group were produced at the station. Ten new inbred lines were used in making up the all-combination single crosses. About 150 Massachusetts lines were top-crossed with three different testers to evaluate combining ability, and 75 predicted double crosses were tested to estimate performance.

Massachusetts 63 (W9 x WM13) X (Q83w x NY3) is an early-maturing hybrid suitable for grain and can be used as a silage corn at high elevations in most of the Northeastern States. Trials over a series of years and under a wide range of conditions have shown Massachusetts 63 to mature early and yield better than most hybrids in its maturity group, and produce an excellent quality yellow grain. This hybrid is now in commercial production and available to the farmers in the Northeastern States.

—H. M. Yegian.

**Castor Pomace in Onion Fertilizers.** Application of castor pomace at the rate of 1000 pounds per acre proved to be very beneficial in the production of seed onion. Connecticut Valley onions are grown almost entirely on fine or very fine sandy loam soils low in organic content. The use of castor pomace with the regular commercial fertilizer will improve the physical conditions of the soil and also supply plant nutrients (4.1 to 6.6 percent nitrogen, 1 to 1.5 percent phosphoric acid and 1 to 1.5 percent potash) to maintain growth. It is suggested that the castor pomace be broadcast prior to the final fitting operation of the onion land.

—H. M. Yegian.

**Potato Variety Trials.** To determine which potato varieties produce best under our soil and climatic conditions, field trials have been conducted for several years. Fifteen different varieties of potatoes were grown to study their performance with regard to yield, habit of growth, and resistance to diseases. The five highest yielding varieties were Green Mountain, Chippewa, Essex, Sequoia, and Ontario, ranging from 481 to 413 bushels per acre, respectively. The five lowest yielding varieties were Teton, Pungo, Mohawk, Katahdins and B355-14, ranging from 342 to 305 bushels per acre, respectively. Green Mountain, Marygold, Pungo, Mohawk and Irish Cobblers had the highest percent of starch. For comparing results of similar tests of other stations, the data are published by the Plant Industry Station in their annual report of the "National Potato Breeding Program."

—Karol J. Kucinski and Ralph W. Donaldson.

**Irrigation Studies and Management of Irrigated Soils.** Certain phases of supplemental irrigation have been studied for the past three years. This project is intended to cover all the various phases of supplemental irrigation in general and specialized agriculture in Massachusetts. Set onions increased in yield 25 to 100 percent where irrigated. Japanese millet averaged 82 percent increase in yield with four applications of water totaling three and one-half inches. A hay field pro-

duced 26 percent more hay where irrigated with two inches of water. The quality and yield of irrigated tobacco were generally better; however, too much water may prove unsatisfactory. During a fairly favorable climatological growing season like 1951, the response to irrigation, measured in terms of percent increase in yield, was greater than that observed during growing seasons that would be considered droughty, as in 1949 and 1950.

In a study of the effect of equipment compaction on soil structure and water permeability it was found that water permeability decreased with increased compaction in terms of weight per square inch. Compaction was much less serious at 20 to 25 percent soil moisture on very fine sandy loam than when the moisture was at field capacity. Results indicate that the use of a light tractor on soil of lower moisture content will result in considerably less compaction. Driving heavy tractors or other equipment on a field soon after its irrigation should be discouraged because of the ill effects produced on soil structure and the lowering of the water infiltration rate of the soil.

— Karol J. Kucinski.

**Yield, Vegetative, and Chemical Composition of Forage Crops as Affected by Fertilizer Treatment.** Farmers experience great difficulty in maintaining yield and stands of desirable legumes and grasses in hay and pasture mixtures in the Northeastern States. Additional information on the fertility requirements of improved legumes and grasses has been needed.

Field studies were conducted on a well-drained soil, Merrimac sandy loam using Ladino clover, smooth brome-grass, orchard grass, and timothy seeded separately in a split plot field design in 1949, to determine their potassium and phosphorus requirements. Three phosphorus (20 percent superphosphate) applications, supplying 50, 100, and 200 pounds of  $P_2O_5$  per acre, were applied before seeding in bands seven inches apart and three inches deep. Certain plots received an additional annual top-dressing application of 100 pounds of  $P_2O_5$  per acre.

Potash requirements were studied by adding small increments (50 to 100 pounds of  $K_2O$  per acre) after each cutting. In addition, one series received 50 pounds of  $K_2O$  per acre before the first cutting, and two series received no top-dressing or maintenance potash but did receive phosphorus. Less than 10 percent of the Ladino on low potash plots remained at the end of the second crop year. In contrast, the grasses on low levels of potash maintained stands of 60 to 90 percent. The grasses were better able to survive at low levels of soil potash than Ladino. Certain grasses removed much more potassium from the soil than Ladino. For example, during the first crop year, on high potash plots Ladino removed 157 pounds of  $K_2O$  per acre, whereas orchard grass removed 298 pounds of  $K_2O$  per acre. These plots received a total of 300 pounds of  $K_2O$  per acre during that growing season.

Population studies on Ladino plots at the end of the second year indicated that at all fertility levels, 15 to 20 percent of the stand was Kentucky bluegrass. At the same time, the stand of *Agrostis* sp. (mostly red top and colonial bent) varied from 15 percent of the stand



at high mineral treatments to 70 percent of the stand on low tentreatm plots. This indicates that bentgrass (*Agrostis* sp.) is the real aggressor in driving out Ladino clover, especially as soil fertility levels decline.

The effect of two 100-pound  $K_2O$  top-dressings in 1950 and two 50-pound  $K_2O$  top-dressings in 1951 produced 56 percent greater yields of smooth brome, 125 percent more orchard grass, 100 percent more Ladino, but only 24 percent more timothy hay in the 1951 harvest season. At the low levels of potash the forage yields from timothy in 1951 were 37 percent greater than smooth brome and 140 percent greater than orchard grass. However, by May of 1952, botanical studies revealed that red top and the bent grasses had replaced more timothy than brome or orchard grass.

Yield and botanical studies indicated that timothy requires higher levels of phosphate fertilizer than orchard or smooth brome-grass. Compared to yields produced with 50 pounds of  $P_2O_5$ , the initial application of 100, 200, and 200 plus 100 pounds of  $P_2O_5$  top-dressed annually after the first cutting increased timothy yields 8, 17, and 20 percent, respectively, in 1951. Only the top-dressing application of phosphorus produced appreciable yield increases (11 and 15 percent, respectively) with smooth brome-grass and orchard grass. Although each increment of applied phosphorus increased timothy yields, the percent phosphorus in timothy was not increased. Timothy contained only 55 percent as much phosphorus as smooth brome and orchard grass. Red top and colonial bentgrass had replaced a large percentage of the timothy plants in the 50-pound  $P_2O_5$  plots in 1951, indicating that this level of applied phosphorus was inadequate for timothy on this soil.

From these data it is recommended that (1) 100 pounds each of  $P_2O_5$  and  $K_2O$  (600 pounds of 5-10-10 plus 200 pounds of 0-20-20) be applied before planting Ladino, or smooth brome, or orchard grass; and (2) a top-dressing of 50-100 pounds of  $P_2O_5$  be applied after the first grazing or cutting the first year and 50-100 pounds of  $K_2O$  after each grazing or cutting each year. When Ladino clover is grown in association with smooth brome, orchard grass, or Kentucky bluegrass, 100 pounds of  $K_2O$  should be applied after the first grazing or cutting, and 50-100 pounds of  $K_2O$  after the second and third cuttings. If heavy growth is removed in September, an additional 100 pounds of  $K_2O$  should be applied at that time.

—John L. Parsons, Mack Drake, and Wm. G. Colby.

**Farm Pond Investigations.** Fertilization, management, maintenance, and cost of construction of various types of farm ponds in Massachusetts are being investigated. Preliminary results indicate that it is possible to produce a "bloom" on pond waters with commercial fertilizer (7-7-7) applied at the rate of 100 pounds per acre at weekly intervals for six months, which is comparable to that produced under southern climatic conditions. Black bass weighing two and one-half pounds in their total year of life have been grown in fertilized farm ponds. Last spring, being much cooler and later than normal years, black bass did not reproduce in the bass experimental ponds in Berkshire County. Black bass have reproduced in other ponds in the third year of their life. Information is being obtained on the utilization of farm ponds

for water conservation, water supply for livestock and farm buildings, orchard and vegetable spraying, irrigation, fire protection, and recreation. White perch have been planted in fertilized farm ponds. It is hoped that white perch may do well in ponds having intermediate water temperature required by trout or bass.

—*Karol J. Kucinski.*

## DEPARTMENT OF ANIMAL HUSBANDRY

### VICTOR A. RICE IN CHARGE

**A Study of the Mineral Elements of Cows' Milk.** The element arsenic is being studied this year. Feeding trials have been completed, but the analytical work is still in process. Difficulties encountered have slowed up this phase of work materially. Organic matter must be removed by oxidation before the presence of arsenic can be determined in the milk; a satisfactory method to destroy the organic matter without losing the small amounts of arsenic that may be present has not yet been found. Several procedures have been tried, but even the best of these shows a loss of 90 to 100 percent of known amounts of added arsenic.

—*J. G. Archibald.*

**A Study of Quality in Roughage.** A study of preservatives for grass silage has been made necessary because of the increased cost of such commonly used preservatives as molasses and ground cereal grains. Using a 125-ton concrete silo, the effects of no preservative, molasses, yellow hominy, citrus meal, and sulfur dioxide gas have been compared; further comparisons were made in 32 steel drums of approximately 250-pound capacity using the five above-mentioned preservatives plus three others; namely, ground oats, dried beet pulp, and dried whey. Studies of the chemistry of the silages have included determination of moisture, pH, carotene, total nitrogen, volatile bases, total acidity, lactic, acetic, and butyric acids, amino acids (as a group), crude fiber, ether extract, ash, and nitrogen-free extract. Palatability tests with milking cows have also been made, and losses incurred in the ensiling process have been determined, being partitioned where possible into avoidable losses (mold, rot, etc.) and unavoidable loss (that incidental to the fermentation process).

The work is not completed, but progress to date warrants the following tentative observations:

a. Judged by odor, appearance, and acceptance by the cows, excellent silage resulted from the addition of hominy or citrus meal at the rate of 150 pounds per ton of green crop.

b. From the standpoint of chemical tests, silage made with sulfur dioxide gas (5 pounds per ton) was very good, but it had a peculiar, strong odor and was not so well liked by the cows as silage to which hominy or citrus meal had been added.

c. Molasses and ground oats gave a reasonably good product, but on the whole were not so satisfactory as hominy or citrus meal.

d. Dried beet pulp and dried whey were not satisfactory because of lack of palatability.

e. Good silage was produced without any preservative in the lower levels of the silo; near the top of the silo or in the small containers results without a preservative were unsatisfactory because of objectionable and persistent odors.

f. The need for effective sealing of the top of the silo was clearly evident, especially in the small containers, the tops of which were sealed with plastic covers held in place by large rubber bands cut from old inner tubes. On a few containers the bands snapped after varying lengths of time resulting in top losses from mold and rot, which averaged 21.8 percent. Where the covers remained intact, top losses averaged only 5.65 percent.

g. As in earlier years, the need for careful control of moisture content of the crop was very evident. Excessive moisture (higher than 70 to 72 percent), when allowed to drain away, resulted in large losses due to seepage; if not allowed to drain off, the moisture caused the silage to become soggy and unpalatable.

—*J. G. Archibald, M. L. Blaisdell, and J. W. Kuzmeski.*

## DEPARTMENT OF BACTERIOLOGY

RALPH L. FRANCE IN CHARGE

**Nitrification Studies with Dried Sewage Sludge.** Because of limited supplies of natural organic fertilizer materials, there is a developing interest in the possibilities of dried sewage sludge for fertilizer use. Sludge would provide material that would be useful as humus for soil conditioning, but its value as a source of nitrogen is open to question because most of the readily digestible material in the sludge is digested before it is dried. This leaves a residue that would be resistant to further digestion by soil microorganisms, but it is inevitable that some further microbial decomposition of sludge will take place, however slow the process will be. This poses two questions that must be answered if sludge is to be incorporated into soil. (1) Will the further digestion of the sludge add nitrogen, and consequently nitrate, to the soil? (2) The microorganisms engaged in decomposing the sludge will require a source of nitrogen for their own use, perhaps more than they can obtain from the sludge; will this process deplete the nitrate content of the soil to the detriment of crops growing on it? The project was undertaken to answer these two questions, particularly the second one.

Only preliminary work has been done to date. The sludge tested contained no industrial wastes; the industrial-waste phase will be considered in the future. The soil is a sandy loam characteristic of agricultural sections of the Connecticut Valley. The direct nitrification of ammonium sulfate is being studied in soil with and without added sludge. The nitrate content of the soil is being determined by the phenoldisulfonic acid method (A.O.A.C.). On the basis of limited experimentation to date, results indicate that nitrates are not depleted by the presence of dried sludge and that even a little increase of nitrate may be had from digestion of the sludge.

—*James E. Fuller.*



**Influence of Synthetic Detergents on Coliform Bacteria.** In the course of the investigation of the effects of synthetic detergents in sewage (Mass. Expt. Sta. Bul, 459, p. 18, 1950), there appeared to be a considerable alteration in the cell morphology, colony types, and differential biochemical reactions of the coliform bacteria recovered from the sewage after treatment with the detergents. These effects could have a bearing on the detection and interpretation of coliform bacteria in the laboratory testing of water supplies suspected of having been contaminated with sewage. Pure cultures of *Escherichia coli*, *Aerobacter aerogenes*, and coliform intermediates were subjected to the influence of the several nongermicidal synthetic detergents that had been employed in the investigation mentioned. It was observed that (1) the production of gas was retarded; and (2) colonies from all cultures, including those of *E. coli*, resembled those of the nonfecal *A. aerogenes*. An explanation of the changes would involve a study of the genetics and mutations of these organisms, which was not within the scope of this study. Enough information was obtained to indicate that exposure of these bacteria to the detergents could have an effect on the results obtained in the sanitary testing of rural water supplies.

—James E. Fuller and Sheldon S. Golberg.

**Decomposition of Wood Wastes by Cellulose-Decomposing Bacteria.** The ultimate objective of this study is to develop cultures of cellulose-decomposing bacteria to be employed on a commercial scale for the production of marketable organic chemicals from wood wastes that are now allowed to decay on farms and wood lots. A mixed culture has been found that decomposes cellulose effectively at 55°C. Attention now is being centered on studying the growth requirements of the two organisms of the mixed culture to find what the relationship between them may be and to develop them for rapid and large-scale decomposition of wood wastes.

—James E. Fuller and W. C. Squires.

**Bacterial Flora of the Intestinal Tract of Earthworms.** The prevalence of earthworms in agricultural soil and their contribution to aeration of soil, need no comment. The present study was undertaken to determine the types of bacteria prevalent in the intestinal tracts of earthworms, i.e., whether the worms would have flora characteristic of the species as do humans and animals, including some fishes, amphibia, and birds. The results of the study indicate that the bacteria present in the intestinal tracts of the worms are those common to the soil in which they are found. Complaints are made sometimes because earthworms are found in wells and springs, but it appears unlikely that the worms would add to the water any bacterial types not present in the soil.

—James E. Fuller and Timothy J. Sheehan, Jr.

**Attempts to Improve the Efficiency of Farm and Commercial Vinegar-Making Methods. Determination of Optimum Conditions for the Conversion of Alcohol to Acetic Acid by *Acetobacter*.** The purpose of this investigation is to study the nutritive and environmental requirements of *Acetobacter* for the efficient production of vinegar (acetic acid) from ethyl alcohol and fermented cider. In spite of the fact that vinegar has been made for many years, trouble is frequently encountered by vinegar manufacturers in the efficient operation of their generators. Much of the trouble appears to be due to a dearth of scientific knowledge regarding the air, temperature, and nutritive requirements of *Acetobacter* for the efficient conversion of ethyl alcohol to acetic acid in the vinegar-making process.

Comparatively little research on the nutritive requirements of *Acetobacter* has been reported in the literature. The greater part of this work has been devoted to identification and classification studies. It is anticipated that the present investigation will provide a better insight into the apparently exacting nutritional and environmental requirements of these organisms as well as provide the vinegar industry with an economical enrichment medium that is satisfactory, chemically defined, and reproducible.

Growth factors have been studied including vitamins, minerals, amino acids, and other nitrogenous compounds. Because of the large number of acetic acid-producing bacteria, and the complexity of the problem, only one species can be investigated at a time. Strains of *Acetobacter xylinum*, a typical vinegar-producing bacteria, have been received from various laboratories in this country and Holland. Present data indicate that (1) p-aminobenzoic acid appears to be an essential factor for the growth of *A. xylinum*; (2) riboflavin and pantothenic acid were not required in the medium, but when added together appeared to have a stimulatory effect; and (3) other members of the B-complex vitamins had no effect, whereas some showed a definite growth inhibitory effect.

These results were obtained by (1) the direct weight of growth and (2) the amount of acid produced after 48-hour incubation.

—Warren Litsky in cooperation with W. B. Esselen, Jr., Food Technology.

**Bacteriological Study of Sewage Disposal Plants.** It is self evident, in the light of present day knowledge, that a pure water supply is extremely important on the farm, for household use, feeding of livestock, and use with dairy barn equipment.

At the present time, irrigation farming is becoming more and more important because of the demands on the farmer to produce more food for our people and our allies. With irrigation practices limited to certain parts of our country, the advent of rapid transportation to distant markets exposes the entire nation to the possibility of infection by products irrigated with polluted water. Although only a few epidemics have been charged to contaminated vegetables, it is possible that unrecognized endemic infections and sporadic cases may be caused by eating vegetables grown on contaminated soil.

To evaluate the sanitary quality of water supplies on farms, bacteriological laboratory tests are made that employ coliform bacteria as indicators of sewage pollution. Unfortunately, this test has serious limitations, particularly in view of the fact that this technique may fail to detect coliform bacteria when they are present, and thus a negative test may give a false sense of security. A greater disadvantage of this test is that these organisms, being of soil origin, may falsely condemn pure water.

In recent years new techniques have been developed for the laboratory evaluation of the sanitary quality of water supplies. These tests depend on the detection of fecal streptococci rather than the coliform group as indicator organisms. The method used in this study was perfected by Litsky, Mallmann, and Fifield (unpublished data).

Unlike the coliform bacteria, which may be of nonfecal origin and persist in soil and water for long periods of time, the fecal streptococci have been demonstrated to follow the same survival slope as *Salmonella typhi* in soil and water. Physiologically, they are more closely related to the pathogenic organisms than the coliform group. They are fecal organisms but, unlike the coliform group, are not found in significant numbers elsewhere in nature; therefore, the fecal streptococci are better indicator organisms of sewage pollution than the coliform bacteria.

It is the purpose of this study to investigate the suitability of the fecal streptococci test for the laboratory testing of the sanitary quality of rural water supplies.

This project is in the beginning stages and the data thus far accumulated are not sufficient to justify a detailed report.

—Warren Litsky.

### Studies on the Biotin Content of "Deficient" and Control Diets.

In a series of investigations designed to explore a possible relationship of biotin (a member of the B-complex) to the endocrine and hematopoietic systems of the rat, a biotin-free diet was used since dietary imbalance involving excessive protein intake would be circumvented. However, after 110 days on the deficient diet, none of the characteristic symptoms of the disorder were observed. This indicated that the commercially prepared "biotin-free" ration contained some biotin.

The various rations in these experiments were assayed microbiologically for biotin using *Lactobacillus arabinosus* 17-5. It was determined that the so-called biotin-free diet contained 0.66 mmcg per gram; the laboratory chow, 206 mmcg per gram; the egg white chow, 381 mmcg per gram; and spray-dried egg white alone, 688 mmcg per gram.

It may be noted that, although the biotin deficient diet contained only 0.66 mmcg per gram, 10 grams of diet was sufficient to maintain the rat. In other words, about 6.6 mmcg of biotin daily will offset a biotin deficiency in rats.

Also, these results seem to indicate that an egg white chow preparation is more efficient in promoting a biotin deficiency than a diet which contains exceedingly small amounts of biotin.

—Warren Litsky in cooperation with S. Katsh, Department of Zoology.



# DEPARTMENT OF BOTANY

THEODORE T. KOZLOWSKI IN CHARGE

**Tomato Leaf Mold Caused by the Fungus *Cladosporium Fulvum*.** Another variant of *Cladosporium fulvum* to which some lines of Improved Bay State are completely susceptible has appeared. This has warranted continuation of study in an effort to secure the investigator's objective. Several original lines of Improved Bay State, formerly released to growers, and the investigator's new hybrids, deriving immunity to infection from *Lycopersicon peruvianum* are being selected for highly resistant and immune lines and for desirable commercial type. As of May 1952 the classification and segregation of latest generation progeny for immunity to infection by all forms of the fungus are as follows::

Hybrids	Percent of Population		Very Susceptible
	Immune	Resistant	
2. Impr. Bay State X Peruvianum Hybr. 44 B292	88.9	0.0	11.1
3. Westerfield X Peruvianum Hybr. 44 B292	100.0	0.0	0.0
4. Impr. Bay State X Westerfield	0.0	94.5	5.5
7. Impr. Bay State (Theo. Conrod)	0.0	100.0	0.0
9. Impr. Bay State (Kenneth Briggs)	0.0	100.0	0.0
10. Impr. Bay State (R. Eisenhauer)	0.0	100.0	0.0
11. Impr. Bay State (R. & W. Dustin)	0.0	100.0	0.0
12. Impr. Bay State (E. F. Guba, Waltham)	0.0	97.3	2.7
13. Impr. Bay State X Bay State	0.0	100.0	0.0
14. Impr. Bay State X Vetomold - 121	0.0	100.0	0.0
22. Impr. Bay State X No. 2	100.0	0.0	0.0
23. Impr. Bay State X No. 3	88.9	11.1	0.0

According to the preceding tabulation, the investigator's objective to obtain a commercially acceptable, immune tomato appears near reality. Also Improved Bay State has been purified for high resistance to all strains of the *Cladosporium* fungus, and seed of such will be distributed.

In addition, Hybrids Nos. 2, 22, and 23 were outcrossed with Waltham Forcing in an effort to combine immunity to infection with desirable fruiting characters of this variety. Immune hybrids Nos. 2, 22 and 23 will be released to growers for trials in the fall of the 1952 growing season. If the tomatoes are acceptable, the most promising type will be named and disseminated.

—E. F. Guba, Waltham

**Resistance to *Fusarium Dianthi* Prill & Del., the Cause of a Serious Carnation Wilt Disease.** The literature on carnation wilt diseases has invariably emphasized that development of resistant varieties by breeding may provide an important method of control, but little research has been initiated along these lines prior to the present study. Effort has been directed to control carnation wilt caused by the pathogen, *Fusarium dianthi*. The development of varieties resistant to other diseases can also be a reality because striking examples of resistance to specific diseases occur among commercially grown varieties of carnations and species of *Dianthus* which may be used for breeding stocks.

Resistance to *Fusarium* wilt was determined by surveys and commercial performance of standard varieties in cultivation. Resistance was confirmed by artificial inoculation and infection. Resistant types were used as parent stocks and were self and cross-pollinated where possible.

Procedures thereafter were variable. First, if the seedlings were artificially inoculated, the susceptible ones were lost. Second, the seedling could be multiplied by vegetative propagation. Its reaction to numerous diseases as well as its usefulness for commercial culture was determined. If it had no commercial value, its further propagation was futile.

Only those seedlings that appeared to have commercial value were retained for distribution to select growers for further appraisal, and the best were developed for the trade in accordance with the plan adopted by the New England Carnation Growers Association.

The purification of lines for resistance by repeated selfing was not possible although recognized as a useful source of breeding stock. Studies on the inheritance of resistance and susceptibility were not considered.

The following varieties resistant to *Fusarium* wilt were originated by the investigator and registered by the developer with the American Carnation Society:

Waltham Pink  
Mrs. E. F. Guba

Regal Pink  
Spicy Rose

Of these, Mrs. E. F. Guba was awarded first prize in its color class in the last two annual conventions of the American Carnation Society.

The following seedlings resistant to *Fusarium* wilt are presently being developed by selected growers:

7. Elizabeth Rowe X Helen Hussey. Yellow and pink variegated.
10. Parentage lost. Rose pink.
23. John Briry X Helen Hussey. Orange crimson variegated.
- 23w. Elizabeth Rowe X Helen Hussey. Light rose.
40. Elizabeth Rowe X Helen Hussey. Rose pink.
61. Puritan X Helen Hussey. Yellow crimson variegated.
209. John Briry X Woburn. Dark pink.
213. John Briry X Woburn. Maroon.

This project is terminated with this report.

—E. F. Guba, Waltham.

**Systematology, Ecology and History of the Monochaetiae and Pestalotiae.** Study and identification of specimens, organization of subject matter, and preparation of manuscript have continued. Doubtful and excluded species belonging neither to the genera *Monochaetia* nor *Pestalotia* have been studied and assigned to proper genera. Numerous synonymies are included. Drawings of the various spore forms have been made to show similarities and contrasts. A useful, practical, taxonomic treatment of these genera with host relationships and history is being organized.

—E. F. Guba, Waltham.

**Investigations of Fungicides That Promise Value in Apple Disease Control.** Ferbam and wettable sulfur fungicides were used in various combinations with lead arsenate, 50 percent DDT wettable powder, and methoxychlor, and to these materials were added NuGreen (nitrogen), Epsom Salt (magnesium) and Borax (boron) to determine foliage tolerance and relative scab control. Trials were made to obtain information for guidance of growers and to discourage incompatible combinations. McIntosh, Baldwin, and Delicious varieties were used for the tests. The nutrients themselves were not toxic to scab spores. None of the combined materials tested were phytotoxic, and four applications gave satisfactory scab control. Limitations to the addition of foliage nutrients to pesticide sprays and the policy of the Pomology Department thereto were recognized.

—E. F. Guba, Waltham.

**Frenching of Tobacco.** Inoculating soil with the above-ground portion of frenched tobacco did not contribute the frenching factor to the soil. Plants made from rooted cuttings of frenched tobacco developed normal, healthy plants in soil that was free of the frenching factor. However, when grown in a frenching soil, the plants appeared normal at the lower temperature of 21°C., but at a higher temperature of 35°C. the new growth assumed frenching symptoms, which became more accentuated in successive new leaves.

With proper attention and careful operation, the first symptoms of frenching were made to appear in three days. The evidence is strongly in favor of some soil condition that is the cause of frenching, and this condition is peculiar to soils more related to terrain than to series.

Agricultural Frits, a manufactured product, containing minor elements in a slowly available form, did not prevent the onset of frenching but, by delayed action, later neutralized the frenching factor.

Calcium hydroxide (lime) applied to a frenching soil accentuated the symptoms of frenching as the reaction of the soil approached neutrality. Above neutrality, the symptoms were less severe, and at a pH value of 8.32 the disease was definitely prevented throughout the experimental period of 75 days.

Iron citrate in the soil in near toxic amounts failed to prevent the onset of frenching.

One of the characteristics of frenching is the development of all axillary buds from the terminal region to the root system of the plant.



A spray of a solution containing one-half percent maleic hydrazide was sufficiently absorbed by the leaves to prevent the development of all axillary buds.

—L. H. Jones.

**Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment.** Work was continued on the application of fungicides to cuttings by various methods, with or without root-inducing substances. The fungicides, usually variously diluted with talc or a Hormodin, were applied dry, as powder-dip treatments, to cuttings, or in water. The fungicide that gave best results is Phygon XL. It contains 50 percent 2,3-dichloro-1,4-naphthoquinone. Soft-wood cuttings of *Cornus florida* rooted 35 percent without treatment, 64 or 77 percent after treatment with Phygon XL-talc 1:2 or 1:4. Rooting of soft-wood cuttings of *Rhododendron calendulaceum* was as much improved by Phygon XL-talc 1:1 as by Hormodin No. 3. Summer cuttings of *Stewartia koreana* rooted 10 percent without treatment, 36 percent with talc, 53 percent with Phygon XL-talc 1:1 and 89 percent with Phygon XL.

Phygon XL improved the rooting of cuttings of woody plants when applied undiluted, variously diluted with talc or with a Hormodin powder, or in water.

Cuttings so treated with Phygon XL in addition to a root-inducing substance, indolebutyric acid, or naphthaleneacetic acid usually rooted in larger percentages than cuttings treated with the root-inducing substances alone.

Treatments that gave good results are Phygon XL 0.3 gm. or 0.6 gm. per liter of water used with indolebutyric acid also in water; Phygon XL-talc 1:2 or 1:4; Phygon XL-Hormodin No. 3, 1:2, 1:3 or 1:4; with these powder-dips used alone or after solution-immersion treatments of the cuttings with a growth substance.

November cuttings of *Juniperus horizontalis* rooted better after treatment with mixtures of N-trichloromethylthio tetrahydrophthalimide and talc. November cuttings of *Chamaecyparis Lawsoniana* rooted better after treatment with this fungicide than after treatment with indolebutyric acid. October cuttings of Mugho pine rooted in larger percentages after treatment with Phygon XL.

Summer cuttings of *Rhododendron calendulaceum* rooted better in sand in the greenhouse than in Vermiculite under fluorescent lamps.

—W. L. Doran.

**Improved Methods for the Control of Clubroot and Other Soil-borne Diseases of Plants.** Investigations of the control of clubroot of cabbage and damping-off of vegetable seedlings by fungicides were continued. Especial attention was given to the effects of different soil pH values and different soil moisture equivalents on the control of clubroot of cabbage by mercurous chloride and ground limestone used together. Clubroot was well controlled by ground limestone 125 gm. (per square foot in all cases) and mercurous chloride 0.33 gm. applied

together (the mercurous chloride in a carrier of 5:8:7 commercial fertilizer) to six soils with pH values between 5.3 and 6.8 and moisture equivalents between 7.0 and 24.8 percent.

Weights of cabbage plants were most increased (95.7 percent) by mercurous chloride and lime in Merrimac fine sandy loam and least increased (42.4 percent) by this treatment in Hadley sandy loam. The best control of clubroot by mercurous chloride and ground limestone was in a soil with a pH value of 7.8 before treatment. In soil with a high pH value the disease was not very severe even without treatment.

In soil with a pH value of 5.4, with clubroot severe and no treatment, weight of cabbage plants was increased 124 percent by ground limestone and mercurous chloride used together.

Some work was done with several of the newer organic fungicides used for the treatment of soil. They were applied to the soil either alone or in commercial fertilizer as a carrier. Clubroot was well controlled by pentachloronitrobenzene (20 percent) 4.7 gm. per square foot, by technical dibromobutene 3.0 gm. and by 30 percent sodium salts of dimethyl dithiocarbamic and 2-mercaptobenzothiazole 0.8 gm.

Damping-off was well controlled by the organic fungicides named above, and there was no injury by them to seeds or seedlings of beet, cucumber, cabbage, lettuce, and tomato.

In preliminary experiments there was less damping-off of beet and cucumber seedlings in a heavy soil to which a soil-conditioner, a hydrolyzed polyacrylonitrile, was added than there was in this soil without treatment.

—W. L. Doran.

**Properties of Carnation Mosaic Virus.** Carnation mosaic is the most widespread of the carnation virus diseases. The proper evaluation of the deleterious effects of this disease requires fundamental information regarding the properties and characteristics of the agent responsible for the carnation disease. Studies were initiated, and preliminary investigations indicate that carnation virus has the following properties.

1. The thermal inactivation time *in vitro*, as determined by heating sealed tubes of expressed plant juices from diseased carnations in a constant temperature water bath, is between 63° and 68° for 15 minutes.

2. The most effective H-ion concentration for inoculating test plants (*Dianthus barbatus* L.) using the carborundum technique is about pH 7.0.

3. Infection by the virus does not occur at a pH greater than 8.0 or less than 4.0.

4. The virus is stable in expressed juice at pH 7.0 for 6 hours at room temperature.

5. The dilution end point of carnation mosaic virus is 1:1000 for infectious leaf juice and 1:500 for infectious flower juice.

These studies are being expanded to obtain information of practical application in the control of the disease.

—R. W. Ames and E. C. Gasiorkiewicz, Waltham.

**Effect of Carnation Mosaic, Carnation Streak, and Carnation Yellow Virus on the Production of Carnation Flowers.** The carnation flower has become established as the second leading flower in production. In the opinion of the carnation growing industry, the carnation virus diseases are assuming greater importance. Direct loss from these virus diseases by gradual decline in quantity and quality of flowers may be augmented by the extra labor, time, and money invested in attempts to influence these effects. The effects of these diseases may be so obscure at times that they may go unnoticed until favorable conditions arise and the stock is completely infected and unfit for propagation.

The results of this investigation to show the relative importance of these virus diseases will provide a more intelligent approach to the control of carnation virus diseases and, at the same time, will yield valuable fundamental information for further applied experiments in control.

—*R. W. Ames and E. C. Gasiorkiewicz, Waltham.*

**Determination of Fungous and Bacterial Pathogens in Commercial Propagating Stock of Carnations.** The culturing of carnation cuttings to secure disease-free stock as a measure for the control of disease incidence due to fungous and bacterial pathogens has been promulgated with satisfactory results in some commercial concerns. No controlled experiments have been conducted to determine the actual value of the culturing technique in detecting and eliminating diseased plants and to determine whether such a technique is justified on the basis of increased flower production.

Culturing for the presence of *Fusarium* and Bacterial Wilt of carnations has been conducted on unnamed seedlings. The evaluation of new material contemplated to be released for commercial use will provide an initial step in establishing restrictions on the quality of propagating stock distributed from Massachusetts. Thus, future control may be achieved possibly by certification of carnation cuttings.

—*R. W. Ames and E. C. Gasiorkiewicz, Waltham.*

**Properties and Importance of Some Fungous and Virus Diseases of Carnations and their Control Measures.** Culturing has been carried out as a control measure to initiate clean mother-flocks of carnation plants.

Chemotherapy by the use of two compounds, 1182 (4-chloro-3,5 dimethylphenoxyethanol) and 1207 (2 norcamphane methanol), has been attempted, in a single experiment begun in April and terminated in November 1951. The types of treatment consisted of a variation



from 10 to 28 pre-inoculation and 6 to 22 post-inoculation applications of the two chemicals. The results obtained were thought too insignificant in that disease figures obtained were similar to checks. Only one treatment showed possibilities, but needs clarification with additional experiments.

Diagnostic tests for the presence of carnation mosaic virus by the use of a fluorescence reaction in the presence of an ultraviolet ray have been attempted without success. This procedure needs modification to make it a useful tool.

Qualitative tests used so successfully for stone fruit viruses have yielded negative results when used on carnation virus infected juices.

Host range studies with 27 species of plants from widely unrelated groups have confirmed the local lesion reaction in *Dianthus barbatus* L. (Sweet William) and *Gomphrena globosa* L. (Globe Amaranth). Under the test conditions here, *Gomphrena globosa* L. gave the faster necrotic reaction, by pin point brown flecks that were discernible clearly in three days.

—R. W. Ames and E. C. Gasiorkiewicz, Waltham.

**Chemical Soil Treatment for the Control of Carnation Fusarium Wilt Caused by *Fusarium Oxysporum* f. *Dianthi*.** Fusarium Wilt is one of the major diseases of carnations for which no effective control is known. The fungus is soil-borne and may spread throughout a bench seriously damaging or killing infected plants. Applying chemicals to the soil for the purpose of soil disinfestation or for chemotherapy is relatively new and has received some notoriety. In the search for effective agents, disinfestation ratios of some chemicals in soil and oat cultures have been shown in the laboratory, and greenhouse tests are underway. The following fungicides are being used: Crag F531 Goodrite zac, Dithane Z-78, Natriphene, Chlorobromopropene, and Dibromobutene. Applications as soil drenches were given on a bi-monthly schedule throughout the normal growing season for carnations.

Two chemicals, chlorobromopropene and dibromobutene, have been found highly phytotoxic in the dosages used in the tests. The compounds caused the death of the plants and even after treatments were stopped and plants replaced, residual phytotoxic action took place.

Evaluation of the other compounds as fungicides is under way by compilation of yield data, gross growth characteristics of plants, and culturing tests. Natriphene and Crag F531 consistently enhanced the growth characteristics of both varieties, Virginia Hercules and Northland.

—R. W. Ames and E. C. Gasiorkiewicz, Waltham.

## DEPARTMENT OF CHEMISTRY

WALTER S. RITCHIE IN CHARGE

### Influence of Processing, Distribution, and Storage on the Loss of Ascorbic Acid in Milk.

1. *Store vs. Delivered Milk as a Source of Reduced Ascorbic Acid.* Ordinarily, the ultimate consumer obtains milk for household use by the dealer-retail, house-to-house delivery system, or from a near-by grocery store. The time that elapses between the obtaining of milk from the cow and the ingesting of it by the ultimate consumer is very important because milk loses its reduced ascorbic acid very rapidly during the first few days after it comes from the cow. A study was undertaken to determine the comparative ascorbic acid potency of store- and home-delivered retail commercial milk in the Amherst, Massachusetts, area. One hundred twenty-six samples of commercial retail milk were obtained from four local stores and from five households that were supplied by dairies that delivered house-to-house. Samples of both the store and the delivered milk were taken from quart bottles in which the milk was regularly distributed. The store milk was kept in refrigerated illuminated glass display cabinets. The amount of reduced ascorbic acid in the store milk varied from 2.4 mg. to 6.8 mg., an average of 3.8 mg. per liter. The reduced ascorbic acid in the home-delivered milk ranged from 2.6 to 13.3 mg. with an average of 6.3 mg. per liter. These average values for reduced ascorbic acid were within the range of values reported by various investigators. In considering these very low values obtained for store- and home-delivered milk, attention should be called to the enormous loss of reduced ascorbic acid from milk between the time it is drawn from the cow and it is ingested by the ultimate consumer. Obviously, steps should be taken to reduce this unfortunate loss of an essential constituent of the human dietary.

—Arthur D. Holmes.

2. *Use of Ascorbic Acid Tablets to Enrich Milk for Infant Feeding.* Infants, particularly during the first few months of life, subsist on a very restricted diet ordinarily consisting largely of human or modified cows' milk. Milk has been frequently described as nature's most perfect food, but it is inadequate in such constituents as iron and reduced ascorbic acid (vitamin C). The deficiency in reduced ascorbic acid is usually compensated for by feeding orange juice to infants. Investigators in various laboratories and different localities of this country have reported that 44 samples of orange juice gave 26 different values for ascorbic acid content; that the vitamin C content of oranges varies with picking date, geographical location, variety and rootstock differences; that higher vitamin C values were found in oranges picked from the outside branches of a tree and well exposed to sunlight than in oranges picked from the interior of the same tree; that there was no correlation between the concentration of reduced ascorbic acid in oranges and their weight, amount of peel, or the volume of juice that they contain; and that the average purchaser cannot use the size, color, or cost of oranges as a reliable guide to the amount of juice or the amount of ascorbic acid that they may contain. These observations raised a question regarding the feasibility of correcting the deficiency

of milk used for infant feeding by adding the pure crystalline vitamin in tablet form to milk as it is fed to the infant. Ascorbic acid tablets for enriching milk for infant feeding may be prepared by compounding synthetic ascorbic acid with suitable materials for use as excipient or filler, disintegrator, binder, and lubricant. Assuming an infant receives five feedings of modified milk every 24 hours (and the mother prefers to fortify all the milk), then each tablet designed for enriching the milk contained in a single nursing bottle should contain a minimum of one-fifth of an infant's daily requirements for reduced ascorbic acid. The breast-fed infant's requirements may be met by dissolving in water a tablet or tablets and feeding the solution in place of orange juice. Orange juice expressed from oranges purchased from the local store contains an uncertain and variable amount of ascorbic acid. Tablets designed to disintegrate rapidly provide a convenient means for adding to the infant's nursing bottle of milk a standardized, uniform amount of ascorbic acid sufficient to meet daily nutritional requirements.

—Arthur D. Holmes, Carleton P. Jones, and Francis Tripp.

3. *Stability of Ascorbic Acid in Milk at Different Stages of Processing.* Milk from various species of animals has been continuously included in the human diet since early antiquity. Apparently, empirical observations convinced early man that milk was a satisfactory food. With the passage of time, more and more information has been collected regarding the composition and nutritive value of milk until it is now generally agreed that milk is one of the most complete foods included in the present home dietary. Studies of the composition of freshly drawn milk have repeatedly indicated that milk as it leaves the cow contains a considerable amount of ascorbic acid. In fact, it is reported that the annual national production of milk as it is drawn from the cow, contains as much ascorbic acid as is present in the entire citrus crop of the United States. However, the larger portion of the ascorbic acid originally present in milk never reaches the ultimate consumer. It is lost during the processing, distribution, and storage of milk.

A study was undertaken to determine the stability of the ascorbic acid in milk at different stages of processing. The milk, produced by a mixed herd of University purebred cows, was a mixture of evening and morning milk pasteurized in the morning by the holding method at 143° F. for 30 minutes. The equipment was similar in construction and capacity to that used by commercial dairies. Milk was collected at approximately two-week intervals throughout the school year. At each of the 22 test periods, four samples were collected: one sample from the pasteurizing vat represented the thoroughly mixed cold milk before pasteurization was started; a second sample came from the vat as soon as pasteurization had been completed; a third sample was taken from the first milk that came through the bottling equipment; and the fourth sample was from the last milk to pass through the cooling and bottling equipment. All samples were cooled at once to 40° F., taken to the laboratory, and assayed for ascorbic acid immediately and at four subsequent 24-hour periods. The results of 412 assays showed that the average amount of ascorbic acid in the milk before pasteurization



was 18.4 mg. per liter; after pasteurization, 17.3 mg.; the first milk to come through the equipment, 6.4 mg.; and the last milk as it came into the bottles contained 15.4 mg. per liter. After 96 hours of storage, the average values for the milk sampled at the four stages of processing were 6.9 mg., 6.8 mg., 3.0 mg., and 4.4 mg., respectively, of ascorbic acid per liter. It is apparent from these results that the ascorbic acid in the milk taken at the four stages of processing is very unstable and that it is rapidly lost from milk stored in darkness at 10° C. under conditions similar to those of many homes. These results add further evidence of the need for replacing the extensive loss of ascorbic acid during the commercial processing of milk.

—Arthur D. Holmes.

### Changes in Vitamin Content Coincident with Different Stages and Rates of Maturity of Vegetables for Home Consumption.

1. *Factors Affecting the Storage Life of Butternut Squashes.* The butternut squash, *Cucurbita moschata*, is one of the newer varieties of squashes grown on a commercial scale in this locality. Its popularity and the acreage devoted to it are increasing rapidly. The home gardener finds butternut squash, which has a superior flavor, very desirable because it is a prolific producer and because the vines require much less space than those of many other varieties. It can be used in the immature stage as a summer squash and in the mature stage as a winter vegetable. Furthermore, this squash is a good source of a number of nutrients essential for an adequate human diet. It is relatively rich in carotene, the precursor of vitamin A, during both the immature and mature stages. Unfortunately, the commercial growers and market men consider them poor keepers and plan to dispose of all butternut squashes by the end of December.

A study was undertaken to determine the possibility of lengthening the storage life of butternut squashes. The project covered three winter storage seasons and included squashes raised during three successive growing seasons. All the squashes were grown under cultural conditions generally employed in this locality by commercial vegetable gardeners. The length of the experimental periods was determined by the storage life of the squashes, that is, the rate at which it was necessary to discard the squashes because of spoilage. The experimental periods were 63, 90, and 188 days, respectively. Each year during the experimental period the squashes were stored in a dry, well-ventilated laboratory attic. One group was stored in continuous darkness, and the other in controlled artificial illumination. The atmospheric temperature and the relative humidity surrounding the squashes were continuously recorded with a Freiz automatic recording hydrothermograph. Judged by the results obtained from frequent observations and weighings of individual squashes, the continuous presence or absence of light does not materially affect the amount of loss in weight of butternut squashes during winter storage. Thus, considered from a commercial standpoint, it is easier and less expensive to store squashes in darkness than under continuous uniform artificial illumination. The spoilage losses of the butternut squashes were due to black rot caused by the fungus *Mycosphaerella citrullina*. In each of the yearly periods the

spoilage losses were significantly greater for the squashes stored in continuous light than for those stored in darkness. These results suggest strongly that under commercial conditions spoilage losses will be significantly less for butternut squashes stored in the conventional, unlighted squash houses than for squashes stored in glass greenhouses frequently used for this purpose.

—Arthur D. Holmes.

**The Production of Holocellulose from Nonwoody Plant Tissue.** In an experiment to prepare holocellulose in a condition suitable for the immediate extraction of hemicellulose, the procedures followed led to the development of a modification of the Norman-Jenkins procedure for the determination of cellulose. The modification is different in that it involves the use of the centrifuge, filtersticks, and the substitution of sodium chlorite for alternate treatments with alkaline sodium hypochlorite and sodium sulfite. The use of this combination of factors results in a saving of time, a greater degree of precision, and the production of a cellulose that is quantitatively and qualitatively similar to that obtained by the Norman-Jenkins method. In general, the quantitative yield of cellulose is slightly greater by the modified procedure. The cellulose so obtained usually contains a slightly lesser amount of furfural-yielding substances and lignin than that obtained by the Norman-Jenkins method. This fact plus the higher yield of cellulose would indicate that the modified procedure may retain some hexosans, which are removed by the Norman-Jenkins method. The difference, however, is so slight as to be of doubtful significance one way or another.

Since lignin is the substance most difficult to remove, it is desirable to obtain more information regarding the behavior of this substance. Accordingly, by means of the Abramson cell a pH-mobility study of pure lignin, methylated lignin, and oxidized lignin containing nitrogen was made. At the same total ionic strength the patterns were different, but in no instance was evidence obtained which indicated an isoelectric behavior within practical pH limits.

—Emmett Bennett.

**Investigation of Agricultural Waste Products. II. *The Chemical Composition of certain Wild Plants, with Special Reference to the Content of Alpha Cellulose, Polyuronides, Gums, and Soluble Sugars.*** The work described in the Annual Report for 1951 has been extended and completed. Further comment at this time does not appear warranted. The final report was issued March, 1952 and the project closed.

—Emmett Bennett.

**Boron Accumulation and Movement in Well-Drained Soils.** Four rates of boron (0, 3, 6, and 12 pounds B/acre) were applied to plots on a well-drained soil, Merrimac fine sandy loam, as sodium borate in April 1949 and again in April 1950. The plots were sampled at 0- to 8-inch and at 8- to 16-inch depths in November 1949, 1950, and 1951, and available boron was determined by boiling water to study accumulation and movement of boron in the soil. In November 1949 the 0- to

8-inch depth of soil contained in available form 73, 50, and 43 percent, respectively, of the amounts of boron in the 3-, 6-, and 12-pound applications. The 3, 6, and 12 pound applications were repeated in April 1950. In November 1950 the 0- to 8-inch layer of soil contained amounts of available boron equal to 37, 27, and 25 percent, respectively, of the 6, 12, and 24 pounds of applied boron. By November 1951, available boron equal to 27, 15, and 11 percent, respectively, of the 6, 12, and 24 pounds of applied boron remained in the 0- to 8-inch layer of soil. A large part of the applied boron moved down and out of the root zone as the 8- to 16-inch soil layer (subsoil) contained amounts of available boron equal to 10 to 15 percent of the applied boron.

On this sandy well-drained soil a large part of the heavy applications of soluble boron (6 to 12 pounds/acre) was leached out of the primary root zone of most agricultural plants. However, amounts of the 3- to 6-pound application of soluble boron are retained by the soil in the second crop year in quantities adequate for those high boron requirement crops, such as alfalfa and Ladino clover.

Farmers who grow alfalfa are often concerned about residual boron causing injury to boron sensitive crops that follow alfalfa. These data indicate that on well-drained soils, one application of three pounds of boron (30 pounds borax per acre) can be made at seeding time for a two-year stand of alfalfa without danger of (1) boron deficient alfalfa or (2) injury to subsequent vegetable crops sensitive to boron.

—Mack Drake.

### **Relationship Between Cation Exchange Capacity of the Plant Root Colloid and Relative Monovalent Cation Adsorption.**

Mattson, Wiklander, and associates have demonstrated a fundamental relationship between the cation exchange capacity of a colloid and the relative adsorption of monovalent and divalent cations. Colloids of high cation exchange capacity adsorb divalent cations as  $\text{Ca}^{++}$  with greater energy than such monovalent cations as  $\text{K}^+$ . Conversely, colloids of low cation exchange capacity adsorb monovalent cations with greater energy than divalent cations. They have shown that this relationship holds for plant roots, as plant roots have cation exchange capacity. Furthermore, the colloid of the plant root must compete with soil colloids for cations. This relationship is expressed most clearly when nearly all the cations are held in exchangeable form by soil colloids. As the cation activity in the soil solution is increased by adding fertilizer salts such as KCl, this relative difference in adsorption of monovalent cations is decreased.

This fundamental relationship should serve as a useful aid in studying fertility requirements of crops. For example, many legumes as alfalfa and the clovers have roots with relatively high cation exchange capacity. Since root colloids with high cation exchange capacity adsorb the divalent cation calcium with greater energy than the monovalent cation potassium, a high activity of K in the soil solution is required to cause an adequate amount of K to enter the high cation exchange root. Unless the soil is naturally high in available K, this element must be supplied by liberal fertilizer applications. In contrast, the roots of grasses are much lower in cation exchange capacity. Since root colloids with low cation exchange capacity as some grasses adsorb the



monovalent cation potassium with greater energy than the divalent cations, these grasses with low exchange roots are able to adsorb potassium from a soil solution in which the K activity is extremely low. This explains the ability of many grass species to persist on soils very low in available potassium.

It is believed that the mineral composition of plants is largely determined by physical-chemical relations between the colloidal systems of both the plant root and the soil. Plant material of legume and of other plants with roots of high cation exchange capacity, contain larger amounts of Ca and Mg than grasses and other plants with low cation exchange roots, not because these legumes require larger amounts of Ca and Mg but because the nature of the root colloid forces larger amounts of Ca and Mg into plants with high cation exchange roots. It follows that legume and other plants with high cation exchange roots must be liberally fertilized with K, not because these plants have a higher K requirement, but because the nature of their root colloid is such as to require a high concentration of K in the soil to overcome the valence effect and thereby obtain sufficient K within the plant for normal growth.

There are many advantages in growing legumes and grasses in association for hay and pasture. However, in addition to the plant root colloids competing with the soil colloid for cations, the colloids of the grass and of the legume root must also compete for cations. In theory, the more nearly equal the cation exchange capacity of the grass and the associated legume root, the more compatible the plants should be for cations, particularly K. Since there are relatively large differences in cation exchange capacities of the roots of grass species, these values are being used in the search for more compatible grass legume combinations.

—Mack Drake, Dale H. Sieling, and Jonas Wengris in cooperation with the Chemistry and Agronomy Departments.

## THE CRANBERRY STATION EAST WAREHAM, MASS.

H. J. FRANKLIN IN CHARGE

With the elimination of the 1950 cranberry crop on the state bog because of summer flooding to control grubs, it was not surprising that the 1951 crop was very satisfactory, amounting to over 1300 barrels. After deducting the usual harvesting, packing, shipping, and selling expenses, the net return to the State was \$9,341.61. The Massachusetts crop as a whole is estimated to have amounted to 590,000 barrels, the largest cranberry crop the State has ever produced, except those of 1948 and 1950. The keeping quality of the crop as a whole proved to be rather poor, as had been forecast by the Cranberry Station.

**Injurious and Beneficial Insects Affecting the Cranberry.** A new bulletin, published as a supplement to Bulletin No. 445 and containing much new information especially about cranberry scale insects, was prepared and presented for publication.

Considerable plot work was done to test the value of dry lime-sulphur and of superior oils as controls for the cranberry scale (*Aspidaspis*). The results on the whole were unsatisfactory because proper coverage, especially of the lower stems, was difficult. It is believed as a result of these studies that late-holding of the winter flood is the most promising treatment for scale insects on cranberry bogs. The fact that the recent upsurge of this pest in New Jersey and in the more southerly part of the Massachusetts cranberry district is occurring in conjunction with a succession of mild winters seems suggestive. Experiments with burlap and black-paper covers, to determine whether the oxygen content of the water on the bogs is involved in this had inconclusive results.

Commercial treatments of bogs and treatment of experimental areas to determine more particularly the values of ryania in certain cranberry pest controls were not wholly satisfactory in their results and must be repeated. At present, it seems probable that this material may be used to advantage as follows:

*As a dust:* 50 pounds of 50 percent dust to an acre.

1. As the first treatment for the cranberry fruitworm.

2. As an early treatment for the black-headed fireworm.

*As a spray:* 7 pounds of 100 percent material in 100 gallons of water, 400 gallons to an acre, to provide the same controls as those already indicated for the dust.

The 15 percent dust with a synergist seems to be too unreliable.

### Prevalence of Cranberry Insects in the Season of 1951

Root grubs	- - - - -	Much reduced by effective treatments from the condition of a number of years ago
White grubs	- - - - -	Normal
Grape Anomala	- - - - -	Very light (None found)
Gypsy moths	- - - - -	Trace (None found in Plymouth and Barnstable Counties)

False army worms . . . .	Light
Blossom worms . . . .	Light
Weevils . . . . .	Normal to heavy (Appear to be increasing in Plymouth County)
Black-headed fireworms . .	Normal to heavy
Yellow-headed fireworms .	Light
Blunt-nosed leafhoppers .	Normally abundant
Spittle insects . . . . .	Normally abundant
Tipworms . . . . .	Normal to heavy
Fruitworms . . . . .	Rather more abundant than usual
Green spanworms . . . .	Normally abundant
Brown spanworms . . . .	Very light
Spotted and Black cutworms and Army worms	Very light
Girdlers . . . . .	Light, but increasing
Brown grasshoppers . . .	Normal
Cranberry scale . . . . .	Abundant on many bogs and apparently increasing
Bees . . . . .	Much more abundant (especially the bumblebees) than for many years
Ladybugs . . . . .	Normal
Springtails . . . . .	Normally abundant
Firebeetle and Red mite .	None found

—H. J. Franklin.

**Frost Forecasts.** Afternoon and evening forecasting of frosts for the cranberry bogs was sponsored by the Cape Cod Cranberry Growers' Association and continued as in previous years, there being 178 and 188 subscribers to the special telephone service during the 1951 and 1952 seasons, respectively. Frost warnings, prepared in cooperation with the Office of the United States Weather Bureau at Logan Airport, were sent out by radio through Stations WBZ, WBSM, and WOCB in 1951 and 1952.

—H. J. Franklin.

**Control of Cranberry Bog Weeds.** A wide variety of chemical weed killers were subjected to tests during the past year. Those to which the most time was devoted are reported here.

Samples of clear, colorless kerosene were obtained from eight leading refineries each of whom delivered 100 gallons to the Cranberry Station. These oils were tested in series tests under a wide variety of field and weather conditions, and samples of each oil under code numbers were laboratory tested and analyzed, gratis, by the Standard Oil Development Company in New Jersey. It was found possible to account for certain vagaries of field performance in the chemical constitution of the oils. For example, one of the standard kerosenes (which met all the specifications of a kerosene as a heating and lighting oil) regularly burned new growth of cranberry vines under all weather conditions, whereas others did not. This oil had a much lower aniline point (135.9° F.) and a much greater fraction (40 percent) boiling below 400° F.



There is, however, no test short of distillation whereby it could be determined beforehand that an oil would be perfectly safe to use, and since cranberry growers use a little less than 1,000,000 gallons annually for weed control, the oil refineries feel it would not be practical to produce a special weed-killing oil for this purpose.

In the Fall of 1951, tests with heavy applications of kerosene were made on six widely-separated cranberry bogs. Dosage varied from 1600 to 2400 gallons an acre, and all treatments were made during the last week in October. Where the cranberry vines were picked, these oil sprays damaged them to some extent—never over one-third of the vines dying, but often with over 75 percent of the flower buds killed. However, in those areas of the test where the berries were not picked, vine injury was negligible, and the flower buds likewise were not hurt. Poison ivy was reduced about 75 percent with 1600 gallons an acre and 90 to 95 percent by 2000 and 2400 gallons an acre. Wild bean was reduced 50 percent with 1600 gallons an acre, 95 percent with 2000 gallons an acre, and 100 percent with 2400 gallons an acre. Several growers are resolved to try this method on a commercial scale in the Fall of 1952.

Work with the hormone weed killers is continuing, particularly with the spraying of weak dilutions late in August, after harvest, and on bog shores in the winter.

Chloro-IPC tested at recommended dilutions in mid-April, 1952, when cranberry vines were dormant, killed all terminal buds of the vines.

—C. E. Cross.

**Soil Water Studies.** The lack of uniform movement of water for drainage or irrigation, reported in 1947-48, and the vine injury, reported in 1948-49, appear to be related to soil structure and water management. The soils with a large percentage of fine particles drain poorly and, therefore, have shallow roots. Bogs managed with water high in the ditches in the spring are poorly drained and have shallow roots. Soil cores from bogs that produce well contain 13 to 25 percent water, whereas cores from bogs with poor production contain from 35 to more than 50 percent water. Samples collected from bogs with low production are nearly saturated when taken, but samples from bogs that produce large crops are less than 50 percent saturated. Holding a frost flow on the state bog for three nights and two days killed many of the root tips.

—F. B. Chandler and W. G. Colby.

**Fertilizer Requirements of Cranberry Plants.** Urea and superphosphate added to insecticides and sprayed on cranberry bogs greatly reduced the cost of applying fertilizer and eliminated the vine damage commonly observed when dry fertilizer is applied with a wheelbarrow-type spreader.

—F. B. Chandler and W. G. Colby.

## DEPARTMENT OF DAIRY INDUSTRY

D. J. HANKINSON IN CHARGE

### Sanitizing Agents for Dairy Use.

1. *The Amount of Quaternary Salt that Gets into Milk.* When teat cups are dipped into a quaternary or other sanitizing solution immediately before a cow is milked, there is a possibility that some of the solution retained on the inside of the teat cup liners will find its way into the milk. From 5 to 10 ppm of quaternary in milk will delay acid and curd formation in the manufacture of cottage cheese. Tests made with four different makes of milking machines showed the maximum amount of quaternary that might be carried over into the milk to be about 0.6 ppm which is not great enough to delay acid development in milk subsequently used for making a cultured dairy product. The design of the teat cup liners did affect the amount of quaternary carried over into the milk, but the differences were too slight to have any practical significance.

—W. S. Mueller.

2. *Further Studies on Quaternary Ammonium Germicides.* Quaternaries were found to be effective germicides in water high in sulfur content, so-called sulfur waters.

Electrophoretic measurements, designed to indicate the manner in which metallic ions interfere with the germicidal action of quaternaries, support the hypothesis of interference due to competitive adsorption of cations on bacterial surfaces.

The presence of metallic ions, such as calcium and aluminum, in concentrations to inactivate the quaternary almost completely, did not alter the results of analytical determinations of quaternary ammonium compounds by current methods. This indicates that the current quantitative methods for quaternaries measure total rather than active quaternary, and that the inactivation of quaternaries by cations is not due to the formation of any strong irreversible chemical complex.

In the search for better analytical methods for the determination of quaternary ammonium compounds, it was found that as little as 5 ppm of the alkyl dimethylbenzyl type in aqueous solution could be detected by diazotization, followed by coupling of the amine with eosin dye. The value of this procedure in milk is limited, on account of the interfering action of tryptophane and probably other amino acids.

—W. S. Mueller and D. L. Meggison.

3. *The Stability of Chlorine Sanitizing Agents at High Temperatures.* The effect of high temperatures (150° to 212° F.) on the loss of available chlorine from hypochlorite solutions and also from a chloramine solution is being investigated. When solutions containing 100 ppm of available chlorine were held for 30 minutes at temperatures ranging from 150° to 212° F., a gradual loss of available chlorine occurred as the temperature was increased. For calcium hypochlorite, sodium hypochlorite, and chloramine, the loss at 212° F. was approximately 26, 25, and 6 percent, respectively. This loss is less than had been anticipated.

—W. S. Mueller and K. Blazys.

#### 4. *The Destruction of Microorganisms in Milk by Ultraviolet Light.*

The ultraviolet treatment of milk, which would be equivalent to pasteurization, has long been an attractive possibility but has not been realized. A laboratory device for ultraviolet disinfection of liquids was investigated for its effectiveness in treating milk. The effectiveness of the device for treating milk was found to be somewhat less than present-day pasteurization treatment. Further improvements in equipment now available for the ultraviolet treatment of milk should permit greater effectiveness and will be investigated.

—W. S. Mueller.

**Studies on Antibiotics.** It has been reported that enough antibiotic used for bovine mastitis therapy may be carried over into the milk supply and inhibit lactic acid formation by starter cultures during the manufacture of dairy products. The antibiotics, penicillin, streptomycin, penicillin and streptomycin in combination, aureomycin, and tyrothricin, were studied for their effect on the bacteria counts of raw milk, lactic acid starter cultures and human intestinal coliform bacteria.

As little as 0.01 unit of penicillin, 0.1 mgm. of streptomycin, 0.1 mgm. of streptomycin combined with 0.01 unit of penicillin, 0.1 mcgm. of aureomycin or 0.1 mgm. of tryothricin, such as would be present as carry-over from mastitis therapy, were effective in reducing the plate counts of raw milk and retarding the growth of bacteria in raw milk held at 37°C. Streptomycin at the level indicated was more effective than the other antibiotics.

Troublesome inhibition of growth of *S. lactis* starter organisms inoculated into sterile antibiotic milk and incubated at 21°C. was observed with 0.1 unit of penicillin, 1.0 mgm. of streptomycin, 1.0 mgm. of streptomycin combined with 0.1 unit of penicillin, 0.25 mcgm. of aureomycin or 1.0 mgm. of tryothricin.

Studies on human intestinal coliform flora revealed significant reductions in counts when 0.1 mgm. (50 mgm. per day) streptomycin per ml. of milk or 0.25 mcgm. (125 mcgm. per day) of aureomycin per ml. of milk were ingested over a period of five days. Penicillin at the rate of 0.1 unit and 1.0 unit per ml. (50 and 500 units per day, respectively, for five days) did not affect fecal counts, probably because of the elaboration of penicillinase by the coliform bacteria. Tryothricin was not studied.

—E. I. Stoltz and D. J. Hankinson.

**Thermal Effectiveness of High Temperature Short-Time Pasteurization.** Ten commercial installations of high temperature short-time milk pasteurizers were evaluated. Thermocouples were inserted between the plates in the heating section and pasteurized regenerator section to obtain temperature readings at selected points. Using flow rates and volume data for each unit, a time-temperature relationship was established. From these values and established destruction rates for the phosphatase enzyme, "lethality" curves were constructed.



The pasteurizers studied contributed from 213 to 390 percent of the heat necessary to inactivate the phosphatase enzyme. The heating and cooling portions of the pasteurization treatment contributed from 20 to 108 percent of the heat needed to inactivate the phosphatase enzyme. Operation of the pasteurizers above the legal requirements contributed far more to the total "lethal" heat than the rate of heating and cooling.

—*J. L. Foley and D. J. Hankinson.*

## DEPARTMENT OF ECONOMICS

### PHILIP L. GAMBLE IN CHARGE

**Public Land Ownership in Rural Areas of Massachusetts.** To determine the extent and character of public land ownership in rural areas and its effect on agricultural land utilization, relevant data were obtained on a town, state, and county basis. From various documentary sources and from field work it was possible to obtain desirable information on public ownership dedicated to various purposes for about one-half of the rural communities in the Commonwealth. This involved the consideration of State forest and park areas, city and town watershed systems, areas in connection with Federal, State, and County hospitals, correctional and educational institutions, highway systems, and other holdings of various governmental units. Complete records were obtained on the extent of agricultural activities and land use on the area included in the state hospitals, correctional institutions, and infirmaries. Of the total area of 20,631 acres controlled by these institutions, 6,607 acres were in crops and improved pasture, and 7,485 acres in woodland.

In 1950, the number of dairy cattle kept was 2,719; hens and chickens, 56,714; and swine, 4,167. The major crop output consisted of 12,951 tons of hay, 4,130 tons of ensilage, 10,538,000 pounds of vegetables, 1,168,780 pounds of potatoes, and about 1,200,000 pounds of fruit. The livestock products included about 15,519,939 pounds of milk and 716,291 dozens of eggs. In addition, 1,548,550 pounds of various kinds of meat were obtained from the animals kept on the premises. The output was used primarily to supply the food needs of these institutions.

The extent of these agricultural operations and the type of land utilization will be further supplemented by data obtained from the operation of state and county educational institutions and from miscellaneous agricultural units under the jurisdiction of the county government.

The work on this project will proceed with the further collection and analysis of the data related to the extent and character of land ownership in rural areas by various political subdivisions. Consideration will also be given to the conservation methods adopted by public agencies for the conservation of resources in publicly owned areas.

—*David Rozman.*

## DEPARTMENT OF ENTOMOLOGY

A. I. BOURNE IN CHARGE

**Control of Onion Thrips.** Biological studies and field observations have indicated that the onion thrips pass the winter principally as adults in plant refuse in the fields and in grass or weedy growth along the margin of the fields. Thrips populations on set or seed onions usually build up rapidly during hot dry weather in late June through July when the peak of abundance is reached.

Weather conditions in 1951 favored an early build-up of thrips populations. Many fields of set onions were seriously threatened by mid-June, and the attack continued heavy through the growing season.

Tests of insecticides in the experimental plots showed that spray applications of Chlordane, Aldrin, Dieldrin, Toxaphene, and DDT gave an initial kill in direct proportion to the degree of plant coverage. All the thrips feeding exposed on the leaves were killed, and most of those deep in the axils of the center leaves died within 24 hours after spray application. Check plants in the plots had 250 to 300 adults and young thrips per plant. Counts made seven days later indicated excellent residual action and very slight reinfestation. Ryania gave a good initial kill but very little residual effect.

Observations in several commercial fields in which Chlordane was applied by helicopter and in one field where Parathion was applied indicated that the initial kill of thrips was very satisfactory and reinfestation was slow in fields that were thoroughly sprayed. Frequent breakdown (partial or complete) in the operating equipment resulted in imperfect and uneven coverage with varying degrees of control from a good kill in portions of a field to complete failure in others. Further adaptations of spray equipment for aircraft spraying of onions are necessary.

—A. I. Bourne.

**Investigations on European Corn Borer Control.** The corn borer continues to be a constant threat to growers. Those who encountered comparatively light infestation in early market sweet corn discovered the insect in considerable abundance in their late season pickings.

Early spring survey indicated almost no winter mortality of the overwintering larvae after the comparatively mild winter.

Spring development was somewhat slower than normal. The weather during May was mild but dry. The first appreciable rain of May 11 stimulated pupation, and examination of stalks indicated definite pupation by the 15th, reaching 50 percent by the 18th. The cloudy, dry weather extended into June with cool windy days prevailing—conditions that tended to slow pupation and reduce moth activity. The first observation of hatching of eggs and appearance of larvae was during the period June 15 to 17. Egg masses were unusually scarce.

The first spray in the experimental plots was applied June 18. Three applications were made, June 18, 25, and July 2, at seven-day periods.

The whole farm was struck by a violent rain and hail storm in the afternoon of June 17. The owner reported more than two inches of rain in about an hour. Severe hail covered the ground with a white deposit.

The cornfields on slopes were badly washed and gullied, and the plants were severely shredded by hail.

The owner promptly cultivated all the corn plots and did what was possible to prevent further erosion. The plants were given fertilizer application, and made very good growth. New growth soon concealed the injured leaves, but the experimental field at least never recovered fully. The crop was retarded, and the plants did not produce ears of normal grade. The kernels ripened and went past peak quality before the ears were filled out to the tip.

The weather disturbance, hail cutting, and general injury to the fields themselves and to surrounding vegetation undoubtedly affected the degree of corn borer attack. Borer damage was very light in the plantings in the area of the farm most seriously affected by the hail.

Counts of tassel breakage made just before harvest reflected the very light infestation. In the treated plots, plants were 98 to 100 percent free from injury, and only 91 percent of the plants in the check plots showed traces of borer attack.

Examination of harvested ears showed 97 to 100 percent of the corn in treated plots to be free from borer damage. In the unsprayed check plots, however, 94 percent of the ears were borer free. In the treated plots, only six ears of approximately 1500 showed any trace of borer feeding; in the dusted plots, only five ears of nearly 600; in the check plots, twenty ears of 339.

Earlier counts of egg masses in this field in early June showed evidence of a light infestation, but masses were to be found fairly evenly distributed over the field. Evidently, the severe damage to the corn plants and to adjoining weedy borders by the hail caused almost as much damage to the corn borer as to the corn.

—A. I. Bourne.

## Materials and Methods That Promise Value in Control of Insect Pests of Ornamental Shrubs, Shade and Forest Trees, and Forest Products.

### 1. Insect Control Tests.<sup>1</sup> (With hydraulic sprayers.)

*Beech leaf aphid.* Good control was had with a 40 percent TEPP emulsion (0.33 pint) and with 40 percent nicotine sulfate (1 pint) without spray injury.

*Birch leaf miner.* Good control was had with a 25 percent Lindane emulsion (1 pint) and with a 74 percent Chlordane emulsion (1 pint). In each instance two applications were made 15 days apart. One quart of Lindane was even better. No spray injury resulted from any application.

*Eastern spruce gall aphid.* Excellent prevention of galls was had with dormant applications of DN289 (2 quarts) and also with a superior oil (2 gallons). Norway spruce was not damaged by the spray, but DN289 injured adjoining broad-leaved trees with flowers and/or young leaves as well as grass.

*Eastern tent caterpillar.* Promising control was had with the following: (wetttable powders) 25 percent BHC (4 pounds), 50 percent

<sup>1</sup> The quantities of insecticides given in parentheses are the amounts used per 100 gallons of spray.



DDT (2 pounds), Ryanex (1.0 pound); (emulsions) 25 percent CS645A (0.5 pint), 24 percent Dieldrin (0.5 pint), 25 percent DDT (1 pint). No spray damage was noticed.

*Elm leaf beetle.* A 25 percent methoxychlor emulsion (1 quart), a 25 percent Rhothane (DDD) emulsion (1 quart), and a 50 percent Rhothane wettable powder (2 pounds) all gave very promising results without spray injury.

*Fall webworm.* Excellent control was had with a 25 percent Rhothane (DDD) emulsion (1 quart) without spray damage.

*Lace bugs on butternut trees.* Promising control was had with a 35 percent TEPP emulsion (0.3 pint) without spray damage.

*Pine needle scale.* Excellent control was had with a dormant application of DN289 (2 quarts) and with superior oil (2 gallons) sprays on white and mugho pines. DN289 caused severe drop of the old needles of both dormant and actively growing white pines. In each instance the new needles that were present or that appeared later were unaffected. A 50 percent DDT wettable powder (2 pounds) showed promise when applied to Norway spruce when the young scale crawlers were present. No spray injury resulted, but mites seemed abundant on the trees later.

*Rhododendron lace bug.* Excellent control was had with a 12 percent Lindane wettable powder (1 pound) without spray damage.

*Imported willow leaf beetle.* Promising control was had with a 25 percent methoxychlor emulsion (1 quart), a 74 percent chlordane emulsion (1 pint), a 25 percent CS645A emulsion (1 pint), a 25 percent CS674A emulsion (1 pint), and a 24 percent Dieldrin emulsion (1 pint) all without spray injury.

*Spruce mites.* A dormant application of a superior oil (2 gallons) gave promising results on spruce and arborvitae without spray injury. In post-dormant applications a 15 percent Aramite wettable powder (1.6 pounds) gave good control on arborvitae and spruce without spray injury. A 20 percent K6451 emulsion, C1012 (1 and 2 quarts), gave good control, whereas a 50 percent wettable powder form, C954 (1.5 pounds), was almost as good. No K6451 spray injured spruce.

## 2. Spray Injury. (With small compressed air sprayer.)

Except where noted, the following insecticides have been sprayed on a wide variety of broad-leaved deciduous and needle-leaved plants with no noticeable damage to the foliage to date. The amounts of insecticides per 100 gallons of spray are indicated in parentheses.

*Dormant applications.* DN 289 (2 quarts). An exception is white pine where the old needles turned brown and fell off after some dormant and all post-dormant applications. Broad-leaved trees were generally severely injured if sprayed with DN289 after flowers or leaves appeared. Elgetol (1 gallon). Elgetol 318 (2 quarts). Several brands of superior oil (2 gallons).

*Foliage applications.* (June) 25 percent CS645A emulsion (0.75 to 1.0 pint). Twenty-five percent CS674A emulsion (0.75 to 1.0 pint). Twenty percent K6451 emulsion (C1012, 1 to 2 quarts). Fifty percent K6451 wettable powder (C954, C1006, C1016, C1020, each at 1.5 pounds). A superior oil (1 gallon). Sugar maple foliage and the old needles on Norway spruce have been injured by this. Red maple leaves may have been injured too. Twenty-five percent Karathane (1 pound).

EPN300 (0.5 pounds). Twenty-four Dieldrin emulsion (1 to 2 pints). Twenty-four percent Dieldrin wettable powder (1 to 2 pounds). Fifteen percent Aramite wettable powder (1 to 2 pounds).

(August) 25 percent Parathion wettable powder (1 pound) and the same plus charcoal (1 pound). Twenty percent 4049 emulsion (1 to 2 pints). Superior oils (0.5 to 1 gallon).

—*W. B. Becker.*

**A Study of the Chemical and Biological Control of the Japanese Beetle and Other Insect Pests of Lawns under Massachusetts Conditions.** In laboratory feeding tests with foliage from grape vines sprayed in the field, a 50 percent methoxychlor wettable powder and a 50 percent Rothane (DDD) wettable powder, each used at two pounds per 100 gallons, showed promise in killing adult Japanese beetles. Field observations, however, indicated that the spray would have to be applied several times during the time the adult beetles are in flight to prevent serious foliage damage.

During 1951, several long-term Japanese beetle grub proofing plots were started at several different places in the state, and more are planned. Type A milky disease spore dust and a few insecticides are being studied under Massachusetts conditions. Results will not be available for some time.

—*W. B. Becker.*

**Effectiveness of Benzene Hexachloride (BHC) Sprays Against Insect Pests of Unseasoned Logs and Weakened Trees.<sup>1</sup>** One application of a benzene hexachloride spray in the early spring before the insects' flight period has protected recently cut logs of red pine all season against attacks by bark- and wood-boring insects. Logs of cordwood size were used, and all surfaces of all logs were thoroughly sprayed. Complete protection was obtained with benzene hexachloride emulsion sprays down to 0.2 percent gamma isomer content and down to 0.1 percent gamma isomer with a concentrate dissolved in kerosene. A pentachlorophenol solution dissolved in kerosene down to five percent was almost as good. Eight-tenths of one percent methoxychlor, rhothane, DDT, toxaphene, and chlordane emulsions gave varying degrees of protection, but all were much poorer than benzene hexachloride. Round-headed borers and bark and ambrosia beetles were the principal insects found in the unsprayed check logs.

Benzene hexachloride emulsions and solutions of equivalent gamma isomer content gave almost equally good results when ash and maple logs were individually sprayed. Bark beetles were the principal pests of the ash logs, and ambrosia beetles of the maple logs.

Excellent protection against attack all season long resulted from one spray application of a 0.4 percent Lindane emulsion to the outside of piles of red pine logs. (Lindane is the purified gamma isomer of benzene hexachloride.) The trees had been cut during the winter, and the logs (of cordwood size) piled like cordwood in individual piles four feet square. No insects had yet attacked any of the logs when they were

<sup>1</sup> The author is indebted to the Forestry Department for the use of their facilities at the Mt. Toby Forest Reservation.

sprayed in the early spring. Two gallons of a 0.4 percent Lindane emulsion per pile reduced the galleries of round-headed borers 99 percent, of ambrosia beetles 100 percent, of bark weevils 97 percent, and the area infested by bark beetle galleries 91 percent. One gallon at the same concentration reduced these galleries 95, 94, 91, and 46 percent, respectively. One- and two-gallon applications per pile at 0.2 and 0.1 percent Lindane were less effective.

When logs of the same size have been sprayed individually, one gallon of a 0.2 percent Lindane (or gamma isomer content BHC) emulsion was needed to protect only ten logs. Since there were between 79 and 120 logs in each of the piles, this spraying of piled logs of cordwood size involved a considerable saving of insecticide, water, and time.

It would seem that benzene hexachloride or its purified gamma isomer, Lindane, may prove useful in the lumber industry in preventing borers from ruining saw logs left in the woods between spring and fall.

In preliminary experiments, benzene hexachloride emulsion-sprays containing up to 0.8 percent gamma isomer have also been applied to the trunk and foliage of some living healthy white pine trees without causing plant injury. If continued experiments confirm these results with this and other species of living trees, benzene hexachloride or Lindane emulsions may also be helpful in protecting weakened and transplanted trees from fatal attacks by these borers until the trees regain their natural vigor and can resist such attacks.

—*W. B. Becker.*

### **Materials That Promise Value in Insect Control Tests in Evaluation of Common Miticides for European Red Mite Control.**

Tests of three of the more prominent miticides were made in one of the University orchards in which were several of such standard varieties as McIntosh, Cortland, Delicious, and Baldwin. Red mite quite generally present was most abundant on the Baldwin trees, and counts were made from those trees.

The miticides were applied June 13 (combined with the regular third cover spray); June 22 (a special codling moth spray); July 10 (fourth cover spray); and July 23 (a special application for mites with miticides only). In the first three applications the miticides were combined with the standard schedule of DDT plus lead arsenate and wettable sulfur fungicide.

Just previous to the June 13 application, counts showed a red mite population of 2104 per 50 leaves and some tendency toward bronzing. Dimite at one pint per 100 gallons reduced the numbers to 362 per 50 leaves, but this increased to 534 seven days after the application. Dimite applied June 22 reduced the mite population to 13 per 50 leaves but sufficient eggs were left to increase the count to 685 per 50 leaves within a week. After the July 10 application, counts showed no living mites but again sufficient eggs to build up to 484 per 50 leaves in a seven-day period. The spray of July 23 cut this down to six per 50 leaves, and very few eggs were left alive. There was no significant build-up thereafter up to August 20 when mites had fairly well disappeared from the entire orchard.



It appeared that Dimite gave excellent initial kill of the mites but seemed to have less effect on the eggs. However, when the two applications were made on July 10 and 23 the mites were eliminated on the 10th and the "follow up" spray was made in a 12- to 13-day period, which fairly well cleaned up the young mites hatched after the spray of July 10.

It appeared that two sprays at approximately 10-day intervals would be effective in eliminating the old mites and any young from eggs hatching during the period between the July 10 spray and the "follow up" application.

Aramite at 16 ounces per 100 gallons after the June 13 spray reduced the average mite population from 2104 per 50 leaves to 264 in seven days and a still further reduction to 172 mites three days later; however, many eggs were still left alive. Applied June 22 Aramite cut the number of mites to 21 per 50 leaves but sufficient eggs were unaffected so that the mites increased to 742 in a 7 day period. The application of July 10 cut the number of active mites to zero but allowed a build-up to 170 mites per 50 leaves in a week. The application on July 23 reduced the population to four mites per 50 leaves in a two-day period and continued actively for four days further when all adult and young mites were killed. There was no significant increase in mites in this plot thereafter during the season. The application of July 10 evidently killed all active stages and the "follow up" spray 13 days later removed the mites before reaching maturity and before new eggs were deposited.

The material Ovotran at 24 ounces per 100 gallons showed definite ovicidal action. The mite population after the first application June 13 was reduced to 85 mites per 50 leaves and to 20 per 50 leaves by the spray of June 22. Only a few small newly hatched mites were found seven days later. The application of July 10 cut the population to an average of 0.9 mites per 50 leaves, and throughout the remainder of the season no significant build-up was noted nor was any further application made. Records were taken up to August 20 where red mite had disappeared from the entire orchard.

—A. I. Bourne.

**Cabbage Maggot.** Applications of insecticides to cabbage plants in plant bands before transplanting gave complete control of the cabbage maggot without further treatment in the field. The insecticides were prepared as solutions or suspensions in water and applied at the rate of two quarts per flat containing 66 plants. Formulations that were effective in this manner were 18½ percent Dieldrin emulsifiable concentrate one quart in 50 gallons, 23 percent Aldrin emulsifiable concentrate one quart in 50 gallons, 25 percent Dieldrin wettable powder two pounds in 50 gallons, and 50 percent Chlordane wettable powder one pound in 50 gallons.

Field treatments that also gave complete commercial control and were almost effective in the following order were: 1½ percent Lindane dust (two applications), corrosive sublimate solution 1-1280 (two applications), one percent Lindane dust (two applications), 5 percent

Chlordane dust (two applications), 2½ percent Aldrin dust (two applications), and 2½ percent Aldrin dust (one application). In the untreated plots, 73.3 percent of the plants were severely damaged.

—*W. D. Whitcomb, Waltham.*

**Potato Spraying Experiments.** Green Mountain potatoes were planted May 1. The weather during the month was mild but dry with no appreciable rain until the 11th (1.2 inches on the 11th and 12th) and very little more until the closing days of the month (1.5 inches on the 24th and 27th). In spite of the early date of planting, plants were slow in appearing, and growth was slow but steady so that the crop entered June not much ahead of normal.

The first spray application was made June 12 when some of the plants were three to four inches high. The stand was quite uneven, some plants just showing above ground. A very few flea beetles were present, and all plots were given a 10-5-100 Bordeaux.

The full schedule of differential treatments was begun June 20, when the stand had become very even. Very little rain occurred until about the middle of the month but was plentiful thereafter, and growth was excellent.

Much cloudy weather and frequent rains may have influenced flea beetle attack. In any event, the beetles were present in negligible numbers during the month, the first of the summer brood appearing in numbers about mid-July. They were less abundant than usual and were eliminated by DDT in the sprays on July 18 and 25.

Tarnished plant bugs and allied species became very abundant about mid-July, spreading in from the margins of the field. The two applications of DDT on the 18th and 25th, however, removed the pests completely before any damage was caused. An infestation of pink and green aphid threatened during the first week of August, but T.E.P.P. in the application of August 9 removed them and they never threatened thereafter.

No leaf hoppers of any consequence were found in the field at any time during the season. In fact, insect pests in the test plots throughout the season were uncommonly scarce, and the foliage of the plants in all plots was almost unscarred throughout the growing season. Weather conditions on the whole were near normal in most respects with slightly less rainfall than normal.

Because of the prevalence of late blight, upon recommendation by the Extension Pathologist, the plots were sprayed with fungicide up to September 9 to keep the new growth protected.

The plots were dug September 7 while much of the foliage was still alive and green, especially in the plots sprayed with Neutral Copper where plants were superior in appearance to the rest of the field.

Records of harvested potatoes indicated the greatest total yield in the plot receiving the Neutral Copper as a fungicide. Of the two plots sprayed with Bordeaux, the one in which DDT was added in each spray gave slightly greater yield than the one in which DDT was used only at peak attack of insects. The chief difference in each case was in the yield of Grade 1 potatoes. The yield of Grade 2 and cull potatoes in the three plots showed no significant difference.

—*A. I. Bourne.*

**Control of Injurious Insects and Mites in the Greenhouse with Aerosols.** Continued experimental fumigations in the greenhouse indicated that the 10 percent parathion aerosol is more effective for the control of more of the common insect and mite pests than other available formulations. On cucumber and bean plants, treated under controlled conditions, slight plant injury occurred only at extremes of temperature and humidity. At normal greenhouse temperatures of 60 to 80°F. and relative humidities of 60 to 80 percent, no plant injury resulted. The effect of shading plants with cloth for one to six days before exposure to aerosol was insignificant when the temperature and relative humidity were favorable.

Exploratory tests on cucumbers in ground beds with a newly developed aerosol containing 10 percent octamethyl pyrophosphoramidate showed no plant injury but failed to control the greenhouse white fly.

—*W. D. Whitcomb and W. J. Garland, Waltham.*

**Biology and Control of Grape Cane Girdler.** The general abundance of the grape cane girdler was low in 1951 but continued to attract considerable interest. Cut canes were present on all vines in the experimental vineyard by May 25. Normal activity continued until June 4 when maximum temperatures below 50°F. prevented all girdling for two weeks and was an outstanding example of the effect of temperature on the activity of this insect.

Applications of sprays protected the canes for six to nine days with methoxychlor 50 percent wettable powder three pounds to 100 gallons and Dieldrin 25 percent wettable powder one pound to 100 gallons, giving the longest residual action.

—*W. D. Whitcomb, Waltham.*

**Ecology and Control of Common Red Spider.** A newly developed organic phosphate insecticide (Systox) gave great promise for the control of the common red spider when used as a spray or as a soil drench on greenhouse roses. At a dilution of 1-16000 (0.25 cc. per gallon), a 50 percent emulsion of trialkyl thiophosphate in a spray reduced an infestation of spider from 7.4 per leaf to none in 14 days, and in a replicated plot from 61.1 per leaf to none in 19 days. On unsprayed plants the infestation increased from 35.8 spiders per leaf to 137.6 per leaf and caused severe defoliation.

When applied as a systematic insecticide to the soil at the rate of 2 quarts per square foot, infestations of 10 to 63 spiders per leaf were reduced 99 percent in 15 days, and significant reinfestation was prevented for 6 to 9 weeks. No consistent significant difference between dilutions 1-8000 (0.5 cc. per gallon) and 1-16000 (0.25 cc. per gallon) was observed.

—*C. S. Hood, Waltham.*

**Control of Plum Curculio in Apples.** In laboratory studies, methoxychlor definitely killed rather than repelled plum curculio beetles and showed a progressive mortality as the dosage was increased from one-half to two pounds per 100 gallons. Dieldrin showed equal toxicity at dosages of  $\frac{1}{4}$  and  $\frac{1}{2}$  pound per 100 gallons.

In the experimental orchard where the fruit on trees sprayed only with fungicides showed 85 percent damage by the plum curculio, the



following formulations provided 99+ percent protection: 50 percent methoxychlor-lead arsenate 2-2-100, 50 percent methoxychlor 2-100, and 25 percent dieldrin 1-100. A formulation of 50 percent methoxychlor lead arsenate 2-1-100 (97.56 percent free) was significantly more effective than 50 percent methoxychlor-lead arsenate 1-2-100 (88.09 percent free). Previously recommended formulations of lead arsenate 4-100 and 50 percent DDT-lead arsenate 2-2-100 were much less effective permitting 10 to 11 percent damaged fruit.

A part of the orchard studies was a contribution to a cooperative project to evaluate methoxychlor for the control of plum curculio on apples in New England. This project was organized, and the results tabulated and summarized by W. D. Whitcomb. Almost identical applications by eight investigators in six states averaged 97+ percent control from 50 percent methoxychlor 3-100 and from 50 percent methoxychlor-lead arsenate 2-2-100 in orchards where the fruit sprayed only with fungicides was damaged from 15 to 85 percent, averaging 47 percent.

—*W. D. Whitcomb and W. J. Garland, Waltham.*

**Apple Maggot Emergence and Control.** Emergence of apple maggot flies from orchard cages occurred at the anticipated time in 1951. The first fly was observed June 21, the peak number emerged July 21, and the last fly on August 20.

The residue from some of the common insecticides applied to the soil and vegetation in the area where the flies emerged caused a significantly greater mortality where methoxychlor was used compared to lead arsenate.

—*W. D. Whitcomb, W. J. Garland, and E. B. Foote, Waltham.*

**Control of Insects on Cucurbits in Relation to Yield.** Five applications of a commercial rotenone-pyrethrum dust (CPR), a 1 percent lindane dust and a 3 percent and 5 percent TDE (Rhothane) dust to replicated plots of cucumbers, melons, summer squash, and Butternut squash failed to increase the yield of these crops significantly over that from the untreated plants. The best yield from the treated plants followed the use of the rotenone-pyrethrum dust. TDE dust caused severe injury in warm, moist weather and was replaced by methoxychlor dusts in the later applications. With an infestation of 3.3 squash borers per vine on summer squash, rotenone-pyrethrum permitted 1.2 borers, and lindane none. Both lindane and rotenone-pyrethrum dusts, gave adequate control of a moderate to heavy infestation of melon aphids.

Taste tests of fruit from these plots by the Department of Food Technology showed significant but variable off-flavor in cucumbers, pickles, and Butternut squash from plants treated with lindane dust, and slight off-flavor from those treated with CPR (rotenone).

In similar duplicated experiments on Hubbard, Buttercup, Table Queen, and Straightneck summer squash, lindane dusts were applied as follows: 0.5 percent, 4 times; 0.75 percent, 4 times; 1 percent, 2, 3 and 4 times; 1.25 percent, 3 times; and 1.50 percent, 3 times. No striped beetles or aphids infested these plants, and the only vine borers averaging 1.5 borers per vine were in the untreated summer squash plants.

This is remarkable insect control since these pests were generally abundant in near-by plantings. Good yields were obtained throughout this planting, but there was no consistent correlation between yield and the application of the various dusts.

Taste testers reported a noticeable off-flavor from samples of each variety of squash from vines to which dust containing 1 percent lindane or more was applied, but little or no objectionable taste was observed from the low concentration dusts despite an extra application.

—*W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.*

**Effect of Pesticides on Beneficial Insects.** Preliminary laboratory studies of insecticide residues indicated methoxychlor and parathion to be most toxic to adult lady beetles, and lindane and parathion to the larvae of lady beetles. Lead arsenate, 40 percent nicotine sulfate, Aramite, and TDE were relatively nontoxic to both larvae and adults in the same experiment.

In orchard studies, random counts showed no significant reduction in the number and activity of the red spider destroyer, *Stethorus punctum*, after spraying with TDE and TEPP at recommended formulations.

In another orchard with a heavy infestation of the green apple aphid, the two-spotted lady bird beetle became four times as abundant after an application of a quick-acting insecticide with a short residual toxicity (EPN 300) as on trees sprayed with slow-acting formulation with long residual toxicity (DDT plus toxaphene).

—*John A. Weidhass, Jr., Waltham, in cooperation with Massachusetts Society for Promoting Agriculture.*

**Biology and Control of the Birch Leaf Miner.** The birch leaf miner has been one of the most destructive insect pests of shade trees. The common gray birch is very heavily infested, and 25 species and varieties of birch at the Arnold Arboretum were infested in various degrees.

Three generations were observed, and a fourth generation may develop in some seasons. Flies of the first generation emerged May 1 to 15; of the second generation, June 25 to 30; and of the third generation, July 20 to 25. Because the flies oviposit only in newly-opened leaves, the greatest damage is caused by the first generation.

Laboratory and field studies developed effective and practical control by spraying. Satisfactory control of the flies and the prevention of egg laying was not obtained, but nearly perfect control of the eggs resulted from applications of 25 percent lindane 1 pound to 100 gallons, 40 percent chlordane 4-100, 25 percent aldrin 3-100, 25 percent dieldrin 3-100, and 40 percent nicotine sulfate 1-800. The most effective and practical treatments were applied soon after the miners hatched and the larvae were in the first and second instar. At this time 25 percent lindane 1-100, 40 percent chlordane 4-100, 25 percent aldrin 3-100, and 25 percent dieldrin 3-100 all gave excellent control by killing the insects in the small mines and preventing further damage to the leaf. Similar sprays against the older larvae and prepupae were significantly less effective. None of the insecticides found to be effective caused injury to the birch trees.

—*W. W. Cantelo, Waltham, in cooperation with F. A. Bartlett Tree Research Laboratory.*

## FEED AND FERTILIZER CONTROL SERVICES

JOHN W. KUZMESKI IN CHARGE

The feed, fertilizer, and milk testing laws are administered as one service, and the operations of each, with the exception of the milk testing law, are reported in annual control service bulletins.

Under the milk testing law, 6,706 pieces of Babcock glassware were calibrated, and 134 certificates of proficiency in testing were issued. All milk depots and milk inspection laboratories in the Commonwealth were visited at least once to check apparatus and general conduct of the work.

In addition to the regulatory work, the Feed and Fertilizer Control laboratories have examined feeds, fertilizers, and other agricultural materials for citizens of the Commonwealth without charge, whenever the results were considered of interest to the general public or to the Control Services.

Considerable work has been done on research projects in cooperation with other departments of the University and Experiment Station. The results of such work are reported by the departments originating the projects.

**Study of Methods for Destroying the Viability of Noxious Weed Seeds in Screenings.** After harvesting and prior to the milling process, the cereal grains are screened to remove broken grains, weed seeds, and chaff. Similarly, the oil seeds, such as soybeans and particularly flaxseed, are also screened before being crushed or treated with solvent for the removal of oil.

The screenings thus obtained have considerable feed value. Over a million tons of this product are ground and used annually for feeding purposes in this country. However, some lots of ground screenings have been found to contain more than 50,000 whole noxious weed seeds per pound. This has created a noxious weed propagation problem.

Recognizing the need for curbing the spread of undesirable weeds by screenings, the Association of American Feed Control Officials, Inc., appointed the senior author as Screenings Investigator to study the screenings problem and to recommend maximum viable noxious weed seed limits for screenings.

Three methods for treatment of screenings to destroy seed viability were studied. The first two methods are perhaps of only academic interest at present.

1. *Di-electric Heat Treatment.* Samples of screenings were heated in a di-electric oven for 10-, 20-, 30-, 40-, 50-, and 60-minute intervals. The temperatures attained were, respectively, 120, 140, 165, 195, 225, and 240°F. The oven used 40,000 watts per hour at 10,000 volts. The power waves in the oven reversed directions 14 million times a second.

After treatment, germination tests were made on seeds of *Brassica kaber*, *Thlaspi arvense*, *Setaria lutescens*, and *Chenopodiaceae*. The last two are not considered noxious and were included because they appear in large numbers in screenings. Twenty-five seeds of each weed for



each treatment were tested. Complete destruction of seed viability was obtained in all cases for the 50- and 60-minute exposures only. Because of the relatively small number of seeds tested, these trials must be considered as preliminary data. The seeds were heat-treated under the direction of W. R. Flach, Laboratory Director, Eastern States Farmers' Exchange, Inc., Buffalo, New York.

2. *Treatment with High Velocity Cathode Rays.* Samples of screenings were submitted to E. J. Lawton, Research Laboratory, General Electric Co., Schenectady, New York. They were irradiated with cathode rays at doses of 12,500, 25,000, 50,000, 100,000, 200,000, and 400,000 equivalent roentgen units. Seeds of the four weeds named above were planted in pots in a greenhouse to determine not only the irradiation effect on germination but also the delayed effect on the growing plants. Twenty-five seeds of each weed were taken for each dosage level and the control.

The seeds were planted on January 7, 1952, and the plants were discarded on May 12, 1952. The soil in each pot was treated in all respects as uniformly as possible.

a. *Brassica kaber.* Irradiation did not affect germination appreciably at any dosage level. Development of the plants was affected only at the 200,000 and 400,000 levels. Plants from seeds treated at 400,000 all died before maturing.

b. *Thlaspi arvense.* Germination was lowered at 50,000 level, and no seeds germinated from 200,000 and 400,000 dosages. Development of plants was affected at 50,000, and all plants died before maturing from 100,000 and higher levels.

c. *Setaria lutescens.* Germination was lowered at 50,000 level. Development of plants was affected at 12,500 level, and all plants died before maturing from 50,000 and higher levels.

d. *Chenopodiaceae.* Germination was not affected at any level. Development of plants was affected at 12,500 level, and no plants matured from 50,000 and higher levels.

Because of the relatively small number of seeds tested, these data also should be considered as preliminary.

3. *Grinding.* Hundreds of samples of screenings from the principal screenings processors and other sources were examined by the Feed Control Service to accumulate data indicating how much the viable noxious weed seed content of screenings can be reduced economically by grinding under efficient plant operating conditions.

It was found that processors using hammer mills with sharp knives and new 4/64-inch screens can produce ground screenings that in most cases will not contain objectionable numbers of viable noxious weed seeds. Screenings containing an unusually large number of the smaller noxious weed seeds may have to be ground through a 3/64-inch screen.

Since some of the weed seeds have a hard coat, grinding will be necessary regardless of any other treatment to destroy seed viability. Otherwise, a large percentage of the weed seeds would pass through the digestive tract without benefit to animal nutrition. At present, there-

fore, grinding seems to be the most economical method for destroying seed viability and making available to the animal the nutrients contained in weed seeds.

As a result of this study, the Association of American Feed Control Officials, Inc., has adopted a tentative definition limiting the viable primary noxious weed seed content in screenings to 4 per pound and the viable secondary noxious weed seed content to 100 per pound. This has been generally accepted by the feed industry.

—*J. W. Kuzmeski, C. T. Smith, J. Vengris, and  
F. A. McLaughlin.*

## DEPARTMENT OF FLORICULTURE

CLARK L. THAYER IN CHARGE

**The Effect of Nutrient Elements on Growth of Roses.** Roses grown for two years under greenhouse conditions with different amounts of potassium in the soil have not shown any significant variations in flower production, total green weight of cutflowers, length of stem, or character of foliage.

The original soil was a sandy clay loam used by a commercial rose grower and was transported to a greenhouse of the Department of Floriculture for use in these studies. This soil contained 300 to 325 pounds of exchangeable potassium per acre.

All plots receiving a one-inch mulch of cow manure twice during the first year showed an increase in the level of exchangeable potassium from the original 325 pounds per acre to an average level between 600 and 800 pounds per acre. Potassium chloride was applied in an additional treatment at the rates of 2, 3, and 4 pounds per 100 square feet of bench. (These rates are approximately equivalent to 870, 1300, and 1700 pounds per acre, respectively.) The levels to which exchangeable potassium was increased ranged from 900 to 1700 pounds per acre.

Data are being obtained on the uptake of nitrogen, phosphorus, potassium, and calcium as indicated by leaf analyses. Comparable data of the same nature are being obtained from plants grown in a commercial greenhouse. These studies will cover a period of three or four years, which is the normal production period for greenhouse roses.

—*Harold E. White.*

**The Effect of Nutrient Elements and Light on Carnations.** The results of our research this year reveal that high potassium levels in the soil inhibit the intake of magnesium by the carnation plant. The reduction of intake of magnesium in the high potassium plots does not appear to reduce the rate of shoot growth, keeping qualities, stem length, and production. Plants grown on the higher levels of potassium appeared, however, to have better stems.

Last year organic fertilizers, such as Milorganite, Agrinite, and Hoof and Horn, when applied to the surface of the soil, were found to be inadequate in supplying enough nitrogen to maintain proper growth of the carnation plant. This year a heavy application was made and thoroughly mixed with the soil before planting the carnations. Several

additional surface applications were made. At no time during the growing season did any of the plants in the plots or soil tests show adequate nitrates. There was no difference in the "sheen" of the foliage between the organic and inorganic nitrogen plots.

The accumulation of soluble salts is an important factor in the production of florists' crops. From the 6000 or more tests made on greenhouse soils in 1951, we find that many soils run higher than a 100 on the Solubridge. These salt accumulations come about in several ways: *First*, in order to meet production schedules, more fertilizer is added to the greenhouse soils each year. *Second*, the farm manures and peat moss, added each year to the same soil, cause an increase in soluble salts. This condition is particularly true on sterilized soils that have had several years of use. In studying soils of fifty growers for the past two years it has been found that the organic matter will run from 10 to 17 percent. Soils running so high in organic matter may be expected to give trouble, particularly after the soils are sterilized. We suggest an organic matter of 6 to 8 percent for optimum growth. Tests for humus show that these greenhouse soils run extremely high.

Tests for sulfates have indicated very high (VH) concentrations of this ion in our greenhouse soils. It is believed that adding the 5 or 6 pounds of superphosphate to the 100 square feet of bench area each year has complicated our soluble salt condition. Superphosphate has a high per cent of calcium sulfate in it, and, from our studies of last year on the use of gypsum, it was found that sulfates and soluble salts do accumulate when this material is added. If the superphosphate could be applied a year in advance, much of this accumulation of soluble salts could be avoided. When the same soil is used year after year, however, there is no opportunity to allow the soil to become conditioned. The sulfate radical is not leached away as it would be if the superphosphate had been added to the soil in the field the previous year.

To overcome this sulfate situation and to meet the liquid feeding program, the use of a good grade of monocalcium phosphate is recommended. This form has an analysis of 58 percent  $P_2O_5$  which is about three times as high as the percent of  $P_2O_5$  in superphosphate. In our recommendations for monocalcium phosphate, small but frequent applications are recommended.

Lastly, it is recommended that the grower who has heavy soils add large quantities of sand and loosen up the boards in the bottom of the benches to allow for better drainage. Growers who have followed this recommendation have found that they can add large quantities of water, particularly after sterilizing, to leach out any soluble salts. They also find that they can plant into their benches much sooner than they could before adding the sand.

— N. W. Butterfield, Waltham.

**Effect of Light on Prolonged Chrysanthemum Bloom and Change of Flowering Habit.** From experiments at the Waltham Field Station it was found that "time pinching" is the best method of producing good flower spray formation on chrysanthemums. It is recommended



that the rooted cutting be planted directly into the bench. This planting should be done 14 to 16 days before the time pinch. If a poor spray should develop on a variety, "pinching date" should be moved either ahead or back. In this latitude it may be necessary to make this change on some varieties.

—*W. L. Ives, Waltham.*

**Control of Weeds in the Nursery by Chemical Sprays.** Sovasol #5 (Stoddard Solvent) directed to wet weeds and not nursery stock continued to give better results than dinitro weedkillers and 2,4-D preparations, especially for grasses, in the nursery.

Applications of the oil to six-foot hemlocks growing in witch grass sod showed cumulative injurious effects after 4 years on more than half of the plants in the treated area. Bark killing was caused by heavy wetting of the trunk and root killing from oil running down the trunk to the roots rather than by oil penetrating to the roots through the soil.

Seed of some of the more common weeds, gathered in summer and fall, were sprayed with Sovasol #5 to determine the effect of the oil on germination. Although in some cases germination was delayed as much as 5 or 6 days, weed seed, in general, was not killed by the oil.

Stands of well established witch grass sprayed with Sovasol #5 so that the oil runs down the culms and into the leaf sheaths were reduced 95 percent the following spring. Also Dupont's TCA 90 percent (trichloracetate) at 132 pounds per acre, applied the last of August, reduced the stand of witch grass the following spring by 95 percent. Lighter applications were less effective, although even 66 pounds per acre gave noticeably good reduction.

Results with weedkillers, particularly Sovasol #5, have been given to growers and nurserymen in personal consultations, demonstrations, and lectures and have been adopted by them to reduce cost of hand labor. Cultivation and tillage with machinery still remain more economical where they can be used.

—*C. J. Gilgut and Paul F. Bobula, Waltham.*

### **Hardiness of Commercially Available Azaleas in New England.**

A selected list of 114 named varieties of azaleas, five of each, was planted in the open field on April 18, 1951, and mulched with two inches of mixed soft and hardwood sawdust. The collection contained Gable's Hardier Azaleas, USDA Hybrids, Kaempferi Hybrids, Glenn Dale Hybrids, Arnoldiana Hybrids, Chungai Hybrids, and a number of miscellaneous hybrids. Sizes of plants depended on availability and varied, some being from two-inch pots, others one-, two-, or three-year plants twice transplanted in this field, and still others 12 to 15 inches B and B.

On November 7, all plants in the collection were dead above ground, the bark having been killed by frosts on the nights of November 4, 5, and 6, when temperatures went down to 30°F., 28°F., and 26°F., respectively. The roots of many of these plants were still alive in the spring of 1952, but except for an occasional one, the plants did not recover.

Also badly injured or killed were the reliably hardy azaleas *A. poukhanensis*, *A. Kaempferi*, *Rhododendron mucronulatum*, and *R.*

*carolinianum*, but not *A. mollis*, which had been growing three years in a fertilizer experiment. There was no correlation between frost injury and kind or amount of fertilizer the plants received, and it is concluded that fertilizer applications are not a factor that contributes to frost injury of young azaleas.

There is, however, an indication that the amount of rainfall in October predisposes young azaleas to frost injury. In 1948 and again in 1951, when there was frost injury and killing, total rainfall in October was more than four inches. But in 1949 and 1950, when there was no injury, although fall temperatures were as low or lower than in the injury years, the total rainfall for October was 1.2 and 1.6 inches, respectively.

—C. J. Gilgut, Waltham.

**Study of Herbaceous Perennial Material.** The living catalog of herbaceous perennial ornamental plants, suitable for climatic conditions in Massachusetts, was maintained in an attractive and presentable condition throughout the year. No winter protection or mulch is given the plants and those that survive and grow well are considered satisfactory for use in the New England region. There were 67 new plants obtained and added to the garden, either as replacements for 48 lost because of winterkilling, disease, insects, or other causes, or as plants newly introduced to horticulture.

Many of the phlox in the collection were discarded as untrue to name, and other varieties were obtained for study. The *Hemerocallis* collection is up to date with 15 new varieties added and is now receiving critical study.

Foliar nematode still remains the most serious pest of hardy garden 'mums. It was not effectively controlled by sprays or dusts of DDT, benzene hexachloride, or chlordane applied at weekly intervals, a total of 15 times, during the growing season. Results with parathion were inconclusive.

The perennial test garden has been and continues to be a source of information and study for nurserymen, horticulturists, landscape students, and the general public. Among the visitors are people from foreign countries as well as from Massachusetts and other parts of the United States.

—C. J. Gilgut and Paul F. Bobula, Waltham.

**Factors Increasing the Rapidity of Growth of Nursery Stock.** Hybrid rhododendron seedlings grown for selection of good reds to find one or more that propagates easily from leaf bud cuttings showed varying responses to fertilizers. Although growth varied in the eight replicates, in general, it was best where castor pomace and Spurgoon were used at 5 pounds per 100 feet of row worked into the soil at planting time and followed by May side dressings. Progressively less satisfactory growth was obtained from treatments applied in the same manner, except peat moss which was worked in at planting time only, as follows: 2 inches peat moss; Agrico Broadleaf 5 pounds; Milorganite 5 pounds; 5-10-10 at 2  $\frac{1}{2}$  pounds and 3  $\frac{3}{4}$  pounds which were equally good; and 5-10-10 at 1  $\frac{1}{4}$  pounds and 5 pounds which were no better than the unfertilized plants.

The beneficial effect of lime on yews was pronounced. The plants were taller and heavier where ground limestone was worked into the soil to adjust to pH 7 planting time and as surface applications in May. The variety, *Hatfieldi*, responded more favorably to liming than *brevifolia*, *Hicksi*, *dovastoni*, *cuspidata*, and *capitata*. The effects on growth of other treatments, arranged in descending order, were: 2 inches of peat moss worked in at planting time only, 5-8-7 at one ton per acre, no fertilizer, sulfur powder to adjust soil to pH 5.

—C. J. Gilgut and Paul F. Bobula, Waltham.

**Reclaimed Tin Cans for Growing and Merchandising Nursery Stock.** Salvaged tin cans in sizes 10, 4, and 2, some unpainted and others dipped in asphalt paint to reduce rusting and improve appearance, with and without drainage holes near the bottom were used to grow cuttings and also one-year plants of *Pyracantha coccinea* and one-year seedlings (6 to 8 inches) of *Cotoneaster divaricata*. Growing media were soil and combinations of soil, peat moss, native peat, and sawdust.

Growth was not affected by asphalt paint of the dipped cans, but their appearance was better than the untreated cans after one summer and one winter in the open. In cans with holes for drainage, growth was better and more satisfactory than in cans without holes. In the latter, the water, after rains, did not drain out, the soil became waterlogged, and the plants gradually turned yellow, declined, and some died. Soil produced the most vigorous and best appearing growth. Next was a mixture of soil and native peat. Less satisfactory was soil and peat moss, and the poorest were mixtures containing fresh sawdust even when 5-8-7 was added to supply nitrogen. Also, there was more winter-killing in the sawdust mixtures. However, when soil was used in the bottom half of the can, and the upper half was filled with sawdust to reduce the weight, and when sawdust was in the bottom half with soil on top, there was good growth and little winter loss.

—C. J. Gilgut, Waltham.

## DEPARTMENT OF FOOD TECHNOLOGY

CARL R. FELLERS IN CHARGE

**Nonenzymatic Browning in Strained Foods.** Test tube studies have been made to determine critical levels of oxygen required to cause surface discoloration in glass-packed pureed apples, peaches, pears, carrots, green beans, beets, squash, and spinach. Minimum levels of ascorbic acid required to prevent discoloration at various oxygen levels are also being determined. It would appear that darkening can be prevented under such conditions through the addition of adequate amounts of ascorbic acid.

—G. E. Livingston, I. S. Fagerson, W. B. Esselen, R. J. Vilece, M. P. Baldauf, D. E. Westcott.



**Fructose-Malic Acid Reaction.** The nature of the reaction between fructose and malic acid has been investigated to clarify at least one of the fundamental reactions suspected of being involved in the darkening of processed applesauce. The isolation and study of the colored end products of this reaction are being continued. The rates of reaction at different temperatures have been determined. Both darkening and hydroxymethylfurfural formation were found to be accelerated at higher temperatures.

—*G. E. Livingston and I. S. Fagerson.*

**Enzyme Studies on Fresh Pack Pickles.** Work has been continued on the thermal destruction of peroxidase and the role of their enzyme in causing off-flavor in fresh pack pickles. Peroxidase activity in fresh pack pickles is associated with the development of off-flavor and odor during storage. High degrees of peroxidase activity appear to intensify the development of stale and bitter flavors. Purified peroxidase preparations from both cucumbers and horse radish caused similar off-flavors when added to fresh pack pickles. The development of such off-flavors in pickles containing active peroxidase is markedly increased during storage at 35°F. as compared with room temperature storage. This fact has important implications insofar as the storage of such pickles is concerned. These off-flavors were prevented by a pasteurization treatment sufficient to reduce the peroxidase activity to a low level. The addition of the enzyme catalase to pickles did not cause undesirable off-flavors as did peroxidase.

—*W. B. Esselen, M. Labbee, I. S. Fagerson, and E. E. Anderson.*

**Frozen and Canned Dietetic Fruit Packs.** Frozen packs of raspberries, sweet cherries, blueberries, peaches, and pears were put up as water packs and also sweetened with sirups prepared from sucrose, saccharin, calcium and sodium Sucaryl (cyclohexylsulfamate). These packs were evaluated for over-all acceptability by taste panels at the end of 6- and 12-month storage periods. Those packs sweetened with sucrose and Sucaryl were most acceptable, those sweetened with saccharin were generally somewhat less acceptable, and those put up as a water pack were considered least desirable. Corresponding similar packs of fruit were prepared and preserved by means of heat processing. Upon evaluation, results similar to those for the frozen fruit packs were obtained, although in some fruits in the saccharin packs a bitterness developed that was more pronounced than that in the frozen packs.

—*E. E. Anderson and W. B. Esselen, Jr.*

**Pre-Peeled Potatoes.** Investigations were continued on ways of preventing the discoloration of peeled white potatoes at room temperature. Inconsistencies in the treatments advocated by other workers were shown to be due to varying exposures of the peeled potatoes to air before the anti-darkening treatments were started. Very short exposures of pre-peeled potatoes to the oxygen of the air resulted in sufficient oxygen uptake by the enzyme systems of the potato to prevent the treatments from having their maximum effect.

To effect a storage life of 14 days or more, the peeled potatoes must be immersed for 15 seconds in a solution containing 10,000 p.p.m. of sulfur dioxide, then packaged and held at temperatures under 40°F.

—*E. E. Anderson, O. Solstad, and W. B. Esselen, Jr.*

**Relationship of Histological Characteristics and the Tenderness of Meat.** Primal cuts from 52 beef and veal carcasses were objectively tested for tenderness by means of the Warner-Bratzler tenderness testing device. Although tenderness varied a great deal, the samples could be arranged into the following categories in order of their decreasing tenderness: 1) tenderloin (psoas major); 2) chuck, prime rib, short loin, and sirloin; 3) round steak; and 4) neck and foreshank.

Statistical analyses of histological data indicated that as the fiber diameter of a meat sample increased, tenderness decreased. The difference between groups was less significant between consecutive age groups than between groups in which there was an intervening age group.

Microscopic studies revealed that amounts of connective tissue in the various primal meat cuts increased with age. There was also a difference in the amount of connective tissue between the tenderloin and the tougher neck and foreshank muscles.

—*R. L. Hiner, E. E. Anderson, and C. R. Fellers, in co-operation with the U. S. Department of Agriculture.*

**Pasteurization of Fresh Pack Pickles.** Heating rates during the pasteurization of quart jars of fresh pack whole pickles, genuine dill pickles, and sliced bread and butter pickles have been obtained. Heating rates were essentially the same for water spray and tank pasteurization methods. Sliced bread and butter pickles heat more rapidly and uniformly than do whole pickles.

On the basis of data obtained during the past three years, factors that influence the pasteurization requirements of fresh pack pickles have been evaluated. Because of the nonuniformity of the product and the way it is packed into jars, the rate of heat penetration in jars of whole pickles is subject to considerable variation. Pasteurization procedures should be designed to take these factors into consideration. Although such factors as acidity (within limits normally used), ratio of pickles to brine volume, and essential oils and spices may not be of major importance in influencing the effectiveness of pasteurization, they may exert a definite influence, the magnitude of which is governed by the rate of heat penetration and other factors.

—*W. B. Esselen, E. E. Anderson, I. S. Fagerson, and I. J. Pflug*

**Genuine Dill Pickles.** An objection to packing genuine dill pickles in consumer-size packages such as quart jars is that the pickles may be softened by the heat of pasteurization or that pectolytic enzymes such as polygalacturonase may cause further softening during storage. Experimental packs of dill pickles have been made to obtain information on factors that influence the quality of this product when pasteurized. It would appear that in pasteurizing genuine dill pickles a delicate

balance must be maintained between the time required to prevent softening caused by overcooking and the time required to inactivate pectolytic enzymes.

—*W. B. Esselen, E. E. Anderson, and I. S. Fagerson.*

**Thermal Death Time Methods.** A new type of "thermoresistometer" has been developed in cooperation with Professor Irving Pflug of the Department of Agricultural Engineering. This apparatus permits the determination of thermal death time of bacterial spores in the temperature range of 250 to 300°F. Work to date has shown the performance of this apparatus to be satisfactory.

—*W. B. Esselen and I. J. Pflug.*

**Clarification of Apple Juice.** It would appear that pectolytic enzymes are not the cause of the sediment that sometimes occurs in canned or bottled clarified apple juice during storage. The heat treatment given to the juice during usual pasteurization procedures was found to be adequate to inactivate the pectolytic enzymes in commercial enzyme preparation used in the clarification of apple juice. The possibilities of a regeneration of the enzymes are being investigated. The formation of sediment in clarified apple juice does not appear to be a reaction associated with a specific enzyme preparation. Addition of proteolytic and diastatic enzymes to a pectolytic enzyme preparation used to clarify apple juice did not prevent the formation of sediment in the finished product.

—*W. B. Esselen, G. Kohn, and C. R. Fellers.*

**Cranberry Pigments.** The principal anthocyanin responsible for the bright red color of cranberry products is 3-beta-glucosidyl peonidin. This pigment was isolated from the cranberry, purified, and used in buffer solutions to study factors that may contribute to its destruction. The deterioration of this pigment has been studied and attempts made to stabilize it in cranberry products. The pigment is bleached when oxidized or reduced. Peroxidative reactions were important from the standpoint of color destruction. A degree of stabilization of the red color in cranberry juice was achieved by the addition of thiourea, tannic acid, and some phenolic compound. The pigment was more stable in its glucoside state than in the aglucone state.

—*I. S. Fagerson, K. C. Li, C. R. Fellers, and W. B. Esselen.*

**Factors That Influence the Composition of Cranberries.** Studies are being continued on the chemical change taking place in cranberries grown on various bogs and stored under different conditions. The pectin content increases as the fruit turns from green to red and then decreases during storage of the ripe fruit. The methoxyl group as well as the benzoic acid content appears to decrease as the berries ripen and change in color from green to red. Variety, bog location, and temperature of storage appear to influence the pectin and benzoic contents of cranberries.

—*W. B. Esselen, H. Gorfein, and C. R. Fellers, in cooperation with The Cranberry Experiment Station, East Wareham.*



**Effect of Apples on the Retention of Protein and Calcium in the Tissue of the Albino Rat.** Rat-feeding tests were conducted to determine whether or not the daily ingestion of small amounts of apple exerts a beneficial effect on the retention of calcium and nitrogen in the body tissues of the rat. The levels of apple fed approximated the daily ingestion of one and three apples, respectively, by the adult human. The levels of apple fed had no significant effect on the growth and calcium and nitrogen retention in rats.

—*W. B. Esselen, C. R. Fellers, L. P. Parkinson, and M. Labbee.*

**Diet and Cancer.** Hepatic cirrhosis and primary cancer of the liver are commonly associated with each other. It has been reported that diets deficient in choline will induce hepatic cirrhosis in rats. Rat-feeding experiments were set up to explore these findings. Rats fed on a choline-free ration showed no gross evidence of hepatic cirrhosis. It has also been reported that gastric cancer has been induced by feeding "browned" fat as a source of fat in the diet. Five common edible fats were heated for a period of 24 hours at 400°F. and were supplemented with folic acid. Gross inspection of the rats from the "browned" fat group showed no evidence of gastric cancer.

—*L. R. Parkinson and D. W. Sanshuck.*

**Utilization of Chelating Agents in Foods.** Ethylenediaminetetraacetic acid, a chelating or sequestering agent, has been suggested for numerous applications in food products, particularly in the clarification of wine, protection of ascorbic acid in foods, and as a fat antioxidant. A toxicological study of this compound has been made using albino rats. The results of three years of feeding tests indicate no noticeable toxic effect of the compound on the test animals.

—*C. R. Fellers, S. Yang, L. R. Parkinson, and I. S. Fagerson.*

**Inhibitory and Lethal Effects of Spice Oils on Acid Food Spoilage Organisms.** A study has been inaugurated to determine the effect of various spice oils on the inhibition of the growth of known acid food spoilage organisms as well as to determine the effect of these spice oils on the thermal resistance of these organisms at processing temperatures.

Preliminary studies on the inhibition of growth of such organisms as *S. cerevisiae*, *L. fructovorans*, *S. ellipsoideus*, *L. lycopersici*, *B. thermacidurans* and organisms isolated from spoiled pickles in dextrose broth at pH 7.2 and 4.5 indicated that of the oils studied, garlic, mustard, onion, and cinnamon oils were the most effective.

At elevated temperatures, the thermal resistance of the test organisms in a synthetic pickle medium was markedly reduced upon the addition of normal flavoring levels of clove, cinnamon, garlic, and mustard oils.

—*E. E. Anderson, W. B. Esselen, Jr., and A. Handleman.*

**Quality of Processed Foods.** This project, which was initiated last year (see Annual Report 1951), has been continued. During the past year, evaluations of the quality of frozen concentrated orange juice, grapefruit juice, blended orange and grapefruit juice, tangerine juice, canned sweet potatoes, frozen haddock and cod fillets, canned tomatoes, and canned apricots have been made.

**Frozen Concentrated Orange Juice.** Twenty-eight of the more popular brands were examined. Fifty-four percent of these brands were classified as grade A according to the U. S. Department of Agriculture standards. Thirty-two percent were graded B with the remainder below these grades. Reduced ascorbic acid content varied from 28.7 to 51.2 mg. per 100 ml. of reconstituted juice with an average value of 47.0 mg. per 100 ml.

**Frozen Concentrated Blended Orange and Grapefruit Juice.** Quality of the blended product was not so high as the orange concentrate; 18 percent were grade A; 36 percent, grade B; and the remainder, grade D. Reduced ascorbic acid content ranged from 24.6 to 44.3 mg. per 100 ml. of reconstituted juice with an average value of 32.5 mg. per 100 ml.

**Frozen Concentrated Grapefruit Juice.** Eight of the more popular brands were examined. Four were grade A, and four grade B. Reduced ascorbic acid content ranged from 20.3 to 31.2 mg. per 100 ml. of reconstituted juice with a mean of 25.1 mg. per 100 ml.

**Frozen Concentrated Tangerine Juice.** Only two brands of this product were available for examination: one was graded A, and the other was of grade B quality. Reduced ascorbic acid content ranged from 23.0 to 27.7 mg. per 100 ml. of reconstituted juice with a mean of 26.0 mg. per 100 ml.

**Canned Sweet Potatoes.** Thirty-five brands of canned sweet potatoes were examined in accordance with applicable U. S. Department of Agriculture grades for this product. The product was packed as slices, whole, and in pieces, and included vacuum, water, and sirup packs. In general, the over-all quality was good. Forty-six percent of the lots were graded as A, 51 percent as B, and samples of only one brand fell into the D grade. As is usual with many food products, selling price was not a reliable guide to quality.

**Frozen Haddock and Cod Fillets.** Seventeen brands of frozen cod fillets and 15 brands of frozen haddock fillets were evaluated for quality. Only four of the brands of cod fillets were found to be of such low quality as to be classified as D grade. All the brands of haddock fillets were either grade A or grade B and were approximately evenly divided between these grades.

**Canned Tomatoes.** Thirty-nine of the more popular brands of canned tomatoes were examined in accordance with applicable U.S. Department of Agriculture grades. Approximately 10 percent of the brands were grade A; 31 percent, grade B; 31 percent, grade C; and the remainder, grade D. In general, the over-all quality of this pack is not so high as some of the other canned vegetable packs available to the consumer.

**Canned Apricots.** Fifty-four of the leading brands of canned apricots were examined in accordance with applicable government grades. Lots included both half and whole fruit as well as peeled and unpeeled packed in a range of sugar sirups from light to heavy. Of these brands, 41 percent were grade A; 39 percent, grade B; 19 percent, grade C; and only 1 percent, grade D.

—*I. S. Fagerson, E. E. Anderson, C. R. Fellers, and K. M. Hayes.*

**Equilibrium Relative Humidity Studies.** Present methods of determining the equilibrium relative humidity of packaged foods are lengthy and burdensome. This department has been investigating the problem for several years. Preliminary studies indicate that a semi-micro technique recently developed will overcome the objections of present methods. Further studies will be conducted in applying the new method to critical foodstuffs.

—*A. S. Levine and I. S. Fagerson.*

**Rodenticide Investigations.** The use of fortified red squill in rodent control operations has declined somewhat the past year largely because of the great emphasis that has been placed on the use of Warfarin (2-4 acetyl 4-hydroxy coumarin), an anti-blood coagulant, which seems to be a very effective rodenticide. Several new products, which are similar in their mode of action to Warfarin, undoubtedly will appear on the market this year. Studies have been started to determine the relative effectiveness of these di-coumarol derivatives as rodenticides. The samples of fortified red squill examined this past year have been of good quality and are available for rodent control operations where a quicker kill than that obtained by the use of Warfarin is desired.

—*L. R. Parkinson, C. R. Fellers and F. A. Vlach.*

**Vitamin D Investigations.** Further studies regarding the possibility of the use of spectrophotometric analysis for vitamin D in Vitamin D fortified foods have been continued. However, the biological assay still seems to be the best and most accurate procedure. A number of samples of Vitamin D milk produced in the State were assayed biologically and found to contain substantially the amount of Vitamin D stated on the bottle cap.

—*L. R. Parkinson, C. R. Fellers, and S. S. Yang.*



## DEPARTMENT OF HOME ECONOMICS NUTRITION

(M. E. LOJGIN IN CHARGE WHILE A. W. WERTZ  
IS ON LEAVE OF ABSENCE)

**The Nutritional Status of Pregnant Women.** As previously reported (Mass. Agr. Expl. Sta. Bu. 449, p. 87, 1948; bul. 453, p. 62, 1949) this investigation is part of the Northeast Regional Cooperative Project on Nutritional Status. Its purpose is to study nutritional status by three different methods and to determine whether there is a significant correlation of the results of the dietary, chemical, and physical findings. Eighty-one women used as subjects in these experiments were studied during three periods: early pregnancy, late pregnancy, and three months post partum. The dietary findings have been reported previously (Mass. Agr. Exp. Sta. Bul. 469, 1951).

*Blood Chemical Findings.* Comparison of the results during the three periods indicated that the hemoglobin values in late pregnancy did not differ significantly from the values in early pregnancy. There was a significant increase in the hemoglobin values at three months post partum. The blood protein values were less in both periods of pregnancy than at three months post partum. The average hemoglobin, ascorbic acid, carotene, and Vitamin A values for the 81 women during late pregnancy were found to be  $11.9 \pm 0.15$ ;  $0.87 \pm 0.06$ ;  $145 \pm 6.73$  and  $52 \pm 2.6$  mcg. per 100 ml., respectively. This average for hemoglobin is in the so-called medium range for blood hemoglobin values. The averages for the blood carotene and vitamin values are relatively high.

*Physical Findings:* Medical examinations of the pregnant women for pathologic signs that might be associated with dietary deficiencies have been performed by Dr. E. M. Holden of Amherst, Mass. The general appearance of the subjects was good in 90 percent and fair in 10 percent of the cases. Several different symptoms in the eyes were present in a mild form in 24 percent and in a moderate form in 9 percent of the subjects. Pathologic signs of the face such as nasolabial siborrhea and acne were observed in the mild and moderate forms, respectively, in 25 and 8 percent of the cases; several women had acne in the severe form. Cheilosis was present in the mild and moderate state in 42 and 6 percent, respectively, and buccal mucosa stomatitis in 20 percent of the subjects in the mild form. Pathologic conditions of the tongue were found in the mild form and in the moderate form in 28 and 16 percent of the cases, respectively. Gingivitis was detected in the mild, moderate, and severe condition in 54, 5, and 5 percent of the pregnant women, respectively. Two percent of the subjects had a mild thyroid abnormality. There were no cases of neurological condition. The only pathologic symptom observed in the condition of the skin was xerosis, which was present in a mild form in approximately 18 percent of the subjects.

None of these pathologic signs are typical of pregnancy but may be due to various causes. Whether the incidence of these physical signs results from dietary deficiencies and whether the signs are significantly associated with the blood values for certain nutrients may be indicated when the correlation studies are completed.

—A. W. Wertz, M. E. Lojkin, G. C. Hagan, and L. P. Guild,  
with the cooperation of Eugene M. Holden, M. D. of Amherst.

**Dietary Methodology.** This study is being performed as part of the Northeast Regional Cooperative Project on Nutritional Status. Data obtained from studies of the pregnant women, as well as those from studies of subjects in other cooperating experiment stations, were submitted to statistical analysis, and an interpretation of results was made.

Comparison of various methods of evaluating nutrient intake indicated that a one-day record was sufficient for a group. The day of the week selected for observation was immaterial.

A method that indicates the number of subjects necessary for a group and the number of days necessary for an individual to estimate nutrient intake with a desired degree of precision has been developed.

Studies of the subject's ability to estimate food portions indicate that the errors in estimating portion sizes for a group may be within 20 percent. On an individual basis, errors in estimating food servings might be the largest sources of errors in evaluating dietary intake.

—G. C. Hagan, A. W. Wertz, and M. E. Lojkin.

**A Comparison of the Determined and Calculated Amounts of Eight Nutrients in One Day's Food Intake of 21 Subjects.** Detailed studies have been made on the results obtained in previously reported experiments involving a comparison between calculated and analyzed food values (Mass. Agr. Exp. Sta. Bul. 449 p. 58, 1948, and Bul. 453 p. 63, 1949), and a manuscript has been prepared for publication.

It has been found that the calculated values for protein, calcium, phosphorus, thiamine, and niacin do not differ significantly from determined values. However, there were considerable differences between the analyzed and calculated values for thiamine and niacin for the individual food samples as only about one-half of the calculated values fell within  $\pm 15$  percent of the analyzed values for these nutrients. The calculated values for fat were significantly higher than the analyzed values, with 11 of the 21 values falling within  $\pm 15$  percent of the analyzed values. The estimated amounts of riboflavin were consistently and significantly lower than the analyzed values: only five of the calculated values agreed within  $\pm 15$  percent of the analyzed values. The calculated values for ascorbic acid were significantly higher than the analyzed values. Although the mean difference between the calculated value for ascorbic acid and the analyzed value for total ascorbic acid was not significant, the differences for the individual samples were great. This particular agreement in the mean value is probably due to fortuitous circumstance.

From the results of the present study and the published work, it appears that a fairly good estimation of the protein, calcium, phosphorus, and niacin in dietaries may be made by calculation from food value tables. Estimation of thiamine may be too high, although the evidence is conflicting. Calculated values for fat and ascorbic acid would probably be significantly higher than the actual intake, but calculated values for riboflavin would undoubtedly be significantly less than the actual amount eaten. Because of the large differences between calculated and determined values for individual samples and analyses, it would be necessary to have several diet records from the same individual in order to obtain a valid estimation of that individual's intake.

—A. W. Wertz, M. E. Lojkin, and G. C. Hagan.

**Metabolism of Nicotinic Acid in Pregnant Rats.** It has been reported previously (Mass. Agr. Exp. Sta. Bul. 459, p. 64-65, 1950) that there is a marked increase in the excretion of the metabolites of nicotinic acid in pregnancy. In the late stages of pregnancy the excretion of the metabolites by women often exceeds the total intake of nicotinic acid and its precursor, tryptophan. It has also been found that the trend in the urinary excretion of the metabolites of nicotinic acid in the pregnant rat is similar to that observed in human beings. These findings made it reasonable to continue the investigation using rats under controlled conditions that might be unsuitable for human beings.

This investigation consists of three problems: (1) a study of the metabolism of nicotinic acid in pregnant rats fed a synthetic nicotinic acid-free diet with supplementations of known amounts of either tryptophan or niacin; (2) an investigation of the effect of some hormones on the metabolism of nicotinic acid; and (3) a comparison of the metabolism of nicotinic acid in two different strains of rats.

*Effect of Diet.* Values for the excretion of N<sup>1</sup>-methylnicotinamide by a synthetic nicotinic acid-free diet were found to be in the same range as the values obtained for rats on a stock breeders' diet. The two diets contained approximately equal amounts of tryptophan. The increase in the excretions of N<sup>1</sup>-methylnicotinamide towards late pregnancy amounted to about 90 to 100 percent of the pre-pregnancy values for both groups of rats. It appears from these results that the presence of nicotinic acid, at least within the limits usually contained in breeders' diets, has no effect on the metabolism of nicotinic acid in pregnancy.

Increases in the tryptophan consumption of the rats on the nicotinic acid-free diet of 10 percent, and subsequently of 50 percent, resulted in rising levels in the urinary excretion of the metabolites of nicotinic acid. The increases in the excretion of N<sup>1</sup>-methylnicotinamide with the duration of pregnancy reached approximately 120 and 290 percent of the nonpregnancy values for the animals receiving the 10 percent and the 50 percent tryptophan supplementation, respectively. These results indicate that supplementation of the diet with limited amounts of tryptophan results in significantly higher increases in the excretion of the metabolites of nicotinic acid in pregnancy.

The ratio of the excretion of the N<sup>1</sup>-methylnicotinamide to the intake of tryptophan, which is indicative of the amount of nicotinic acid synthesized by the animal from the tryptophan ingested, increased greatly with the duration of pregnancy. In several cases, twofold increases were observed. These findings suggest the conclusion that the high excretion of N<sup>1</sup>-methylnicotinamide during pregnancy might be due to utilization of a greater percentage of tryptophan for synthesis of nicotinic acid during pregnancy.

No definite results are available at the present time from studies of the effect of supplementation of the synthetic diet with known amounts of nicotinic acid as well as with larger doses of tryptophan.

*Effect of Hormones:* The increased excretion of the metabolites of nicotinic acid during pregnancy might be attributed not only to synthesis of nicotinic acid but also to increased utilization of the nicotinic acid stored in the body in the form of coenzymes I and II. This process would be expected to be regulated by the hormones associated with pregnancy. Three hormones were used in this study: (1) pro-



gesterone, which is known as the pregnancy hormone, because it is necessary for the maintenance and successful completion of pregnancy; (2) estrogen which is excreted in increased amounts during pregnancy; (3) testosterone, the principal male hormone, which when injected into females causes a decrease in the production of estrogen.

Under the conditions of these experiments, injection of progesterone produced inconsistent results. Injection of estrogen in the form of diethylstilbestrol, a synthetic product, resulted in repeated cycles of increases, followed by decreases, in the excretion of N<sup>1</sup>-methylnicotinamide; the general trend was an increase. Testosterone produced a definite decrease during the first days of injection. This decrease was followed by an increase during the next few days of treatment.

The number of experiments performed was not sufficient to give quantitative results. However, there is an indication that hormones have an effect on the excretion of the metabolites of nicotinic acid.

*Comparison of Two Strains of Rats.* In the experiments reported so far, the albino rats tested were from a strain originally obtained from the Connecticut Agricultural Experiment Station. A few experiments performed on the albino rats of the Wistar strain indicated that the urinary excretion of N<sup>1</sup>-methylnicotinamide by the Wistar rats is about 80 percent lower than that of the "Connecticut" rats. However, the increases in excretion of N<sup>1</sup>-methylnicotinamide in pregnancy are about 50 percent higher in the Wistar than in the "Connecticut" rats. There appears to be no marked difference between the excretions of nicotinic acid by the rats of the two strains. Further studies might help to understand the reason for this difference in the excretions of N<sup>1</sup>-methylnicotinamide.

—M. E. Lojkin, L. P. Guild, and G. C. Hagan.

## DEPARTMENT OF OLERICULTURE

### GRANT B. SNYDER IN CHARGE

#### Breeding Sweet Corn, Peppers, and Field Tomatoes for Massachusetts.

*Sweet Corn*—The general plant vigor and earliness of maturity in Gold Mine sweet corn have been increased where the hybrid is made using a three-way cross instead of the regular single cross. Seed of the regular Gold Mine is made by crossing Mass. 2410-191 by Conn. 3. The new hybrid is made by first crossing an early strain of Conn. 13 by Mass. 2410-191 and then crossing this hybrid with Conn. 3. After two years of trials it seems reasonably safe to say that the new hybrid is an improvement on Gold Mine.

Inbred lines 21547-1-1 and 21547-1-2 are two distinct strains but have been selected from Maine 2, which is the pollinator for Golden Jewel. These two inbreds are earlier than Maine 2 and they have the desirable white interior silk character, whereas Main 2 has the undesirable very dark interior silk factor. These new selections have been crossed with many inbreds of comparable season of maturity, and several of the resulting hybrids look very promising as varieties for

market corn. Further testing will be necessary before any of these are introduced to the public.

Many of our synthetic varieties have been self-pollinated for two or three times and are about ready for testing. Special emphasis has been placed on selection for such characters as high quality, high row count, white interior silks, dark husk and long flag leaves. Other factors that are receiving attention in this program are the transferring of the glumeless character to several of our inbreds, which should lead to better quality corn, and also the male-sterile particle, which will reduce the cost of producing hybrid seed. Attention has also been given to finding sweet corn inbreds that contain the factor for restoring fertility in hybrids made with male sterile seed parents.

*Tomatoes*—The search for high quality, early market tomatoes continues with most attention being placed on the production of  $F_1$  hybrids to solve this problem. Once again the trials in 1951 established the fact that the  $F_1$  hybrid Red Cloud by Pennheart has the ability to produce more early marketable fruit than any of the early commercial varieties with which it has been compared. Two new  $F_1$  hybrids performed exceptionally well this year yielding more early fruit than the Red Cloud-Pennheart combination. One of these new hybrids also had Red Cloud as one of its parents as did another high yielding hybrid B14 by Red Cloud. These data indicate that Red Cloud has good combining ability in making  $F_1$  early tomato hybrids.

More attention is being paid to the selection of larger fruited parent strains for making  $F_1$  hybrids because of the reduced fruit size in almost all the hybrids that have been produced in this investigation. Starting with large parental strains it seems reasonable to believe that the fruit size of some of the final hybrids should be large enough to meet the demands of the trade.

*Peppers*—The 1951 pepper investigations were hindered because of a crop failure.

—*W. H. Lachman.*

**Weed Control in Vegetable Crops.** Several chemicals are now available that will kill weeds in fields of sweet corn. These chemicals are both effective and efficient. Results for several years indicate that 2,4-D is the cheapest material to use although it is hazardous to apply when sensitive crops border the fields of corn. Best results were attained when 1.5 pounds of 2,4-D acid equivalent from a salt or amine formulation was applied a day or so before the corn plants emerged from the ground. Smartweed was the only annual weed that was not controlled satisfactorily by this treatment.

Sodium pentachlorophenate at the rate of 15 to 20 pounds per acre and Premerge, a dinitro compound, at the rate of 3 to 6 pounds of DN per acre also gave excellent results. These materials were applied to the surface of the soil immediately after planting. They prevented all growth of annual weeds for four to five weeks when the corn was 10 to 12 inches tall, and from then on the crop was easily weeded by cultivation. The period from planting until the corn is 8 or 10 inches tall is the critical time when farmers have most trouble controlling weeds in fields of corn.

CMU, a new weed killer, at the rate of 1 pound per acre gave the most outstanding performance of the 1951 growing season. Since this was the first trial of CMU, more tests will be necessary before definite recommendations can be made.

Delayed applications, just prior to emergence of the corn seedlings, of Granular Cyanamid at the rate of 400 pounds per acre has also given good control of weeds for about three weeks but has injured corn planted on sandy loam or lighter soils.

All the materials mentioned above also gave good control of weeds in asparagus beds without perceptible injury to the crop. Slightly heavier dosage rates seemed to extend the weed-free period. The CMU weed killer at two and four pounds per acre was especially effective in preventing weed growth in asparagus beds during the first six weeks of the growing season.

Pre-emergence applications of weed killers such as those previously mentioned to plots of set onions have usually resulted in reduced yields. This reduction in yield appears to be the result of leaching action that takes place on light sandy soils generally chosen for production of set onions. Three pounds of Chloro-IPC per acre applied eight days after planting in the 1951 trials gave the best results experienced so far with this crop. Further tests are necessary with this material before it can be recommended to onion growers.

—*W. H. Lachman.*

**The Culture and Nutrition of Vegetables.** In the Connecticut Valley the culture of onions grown directly from seed became a hazardous venture with the advent of the disease known as blast. During recent years onion growers have depended on growing their crops from onion sets because blast ordinarily is not such a serious problem when the crop is grown in this manner. Growing them in this way, however, is more costly, and yields are not so good as under the former method of culture.

The recent production of  $F_1$  hybrid onions has opened up a new field of investigation. With this new development it seems feasible to believe that the increased vigor that is possible with hybrids as well as the discovery of one or two inbreds that resist blast, may lead to the production of varieties that will yield good crops from direct seeding once again.

During 1951 we had 37  $F_1$  hybrids and seven standard varieties in replicated tests. None of the varieties showed any blast symptoms. It was very apparent that the  $F_1$  hybrids were remarkably uniform in every respect. Of the 37 hybrids, four significantly produced more onions than the best standard variety.

In further onion tests we had 88 hybrids and three standard varieties grown as green plants and transplanted to replicated plots. These were to determine the possibilities of producing the large Spanish-type onion under conditions found in the Connecticut Valley. Taking the average yield of the replications, 47 of the hybrids yielded more onions than the best standard variety used in the test. It was apparent that early types must be used in order that they may dry and cure properly before cool moist autumn weather comes, otherwise too many onions are lost because of rotting.

—*W. H. Lachman.*



**Seed Improvement.** *Trellis Tomatoes.* The work of breeding a trellis-type tomato resistant to cracking made considerable progress during the year. The best selection cracked only 25 percent as much as Trellis 22, the most popular variety used by local growers. These new selections are not yet so early as Trellis 22 but they are larger.

During the year, work was continued with the A type trellis. In this trellis the posts are set eight feet apart with a row on each side of the trellis and out one foot from it. Both rows are trained to the single wire. The yields, to date, show that only 61 percent as much fruit was picked from this trellis as from the single type. The early yields were not significantly less. There was very little difference in the percentage of cracking on No. 1 fruit. The advantage of this type of trellis is a reduction in cost both for equipment and labor. Whether the advantages of reduced costs balance the reduction in yield in the last half of the season is yet to be determined, but many growers continue to use the A type trellis.

The use of Hormone sprays to set the early blossoms of trellis tomatoes produced results less favorable than those reported previously. The amount of fruit produced in the first two pickings was not much greater than for those not treated. The first picking was much in favor of the hormone sprays. Many growers have been using the spray with success.

*Celery.* Final tests were conducted on some selections developed from a cross between Summer Pascal and Cornell 19. None of these selections proved sufficiently superior to Summer Pascal to warrant further trials. Growers originally complained that Summer Pascal was too short, but as they learned how to grow the variety, there has been general satisfaction. With the exception of variety and strain trials and the maintaining of a supply of stock seed of Summer Pascal celery, the work with this crop has been concluded.

*Carrots.* Trials of carrots conducted in the fall have shown that definite progress has been made in improving the color of Hutchinson carrots. The exterior color compares favorably with Imperator. The interior color shows need for continued improvement. New strains developed from crosses between Hutchinson and other varieties have reached the stage of development where seed is being produced for trial by growers.

—Robert E. Young, Waltham.

**Vegetable Breeding for Improvement of Quality.** *New York Lettuce.* The efforts to breed a more uniform and better adapted strain of lettuce in Massachusetts has progressed to the point where seed of a very early type is being grown so that trials can be made by the growers. Seed of a selection of Great Lakes is also being increased for further trials.

An experiment to determine the factors that cause lettuce plants to produce cone-shaped heads was concluded during the year. The results of two years' trials on the effect of the depth of planting lead to the following conclusions:

1. Transplanted lettuce plants when set too deep will produce a small cone-shaped head.
2. Pennlakes variety is more sensitive to depth of planting than Great Lakes.

3. Deep planting makes small plants and heads that mature earlier.
4. If lettuce is transplanted on a small ridge, the coning is eliminated and there is less disease of the lower leaves.

*Cabbage.* The work of breeding a small-sized cabbage has progressed to the point where a satisfactory type has been selected. Since growers feel that high yields must be maintained if cabbage is to be profitable, the type of plant selected has been one that not only has a small head but a small plant as well. The new selections made have leaves that are cup-shaped as compared to most cabbage varieties where the leaves lie flat on the ground. This cup-shaped leaf exposes a large leaf area to the sun even when crowded in the row. Unfortunately, much of the semisterility that was present in the original material from which this new type was selected is still present, and a program of selecting plants with capacity to produce good seed crops is now in progress.

—Robert E. Young, Waltham.

### **Breeding and Cultural Problems of Greenhouse Vegetable Crops.**

One of the objectives of the work with the spring crop of greenhouse tomatoes is to determine the most economical time to set the plants in the house. Plants were set out on February 1 and 15 and March 1 and 15. The harvest data from this experiment indicate that the earlier the crop was planted, the greater the total yields; the later the crop was planted, the higher the percentage of No. 1 fruit produced. The heat cost is considerably higher for the early crop, but the prices are also greater for the first fruit picked. When the heating costs were subtracted from the gross value of each crop, it was found that the early planted crop produced the greater net profit. This may not be true in years of colder spring weather or different prices.

The work with the fall crop has been to determine whether there are methods of blossom pruning that would eliminate some of the waste that occurs when many small green tomatoes are discarded at the time the crop is pulled out. Blossoms were kept pruned off one set of plants after October 1 and the crop terminated December 1. Although very few green fruit were discarded, there was no significant increase in total yield. There was a slight increase in the percentage of No. 1 fruit, and the average weight of fruit was larger where the blossoms were removed.

Some progress has been made in the breeding of a better strain of radish for greenhouse use. The last crop produced significantly less roots that were not marketable. Further work on uniformity of size is necessary before seed can be offered to growers for trial.

—Robert E. Young, Waltham.

**Asparagus Investigations.** The objective of this work has been to develop a more productive strain of asparagus. The extreme variation in the yields of individual plants of commercial varieties—which may be from 1 to 50 stalks—indicates that if the poor plants can be removed, the yields can be greatly increased. The results from this work, which is now in the process of testing the third generation of plants, indicate that the poor producing plants can be eliminated.

Individual plant yield records were obtained from 400 plants in the four best lines. The highest yielding line produced an average of 21 spears per plant; yet only 6 percent of the plants failed to produce ten or more spears.

During the 1951 season there was a general reduction in the yield of all strains and varieties, which can probably be traced to the dry weather in 1950. The best selection in the trials produced 154 percent of the best commercial variety when the total yield for five years was considered.

Part of the reduction in yield of commercial asparagus planting can be attributed to the reduction in stand that takes place. One of the commercial varieties has now lost 20 percent of the plants in seven years; another, 17 percent. Two of the selections have lost no plants, and the average loss for the best lines is less than 4 percent. At least part of this dying of plants is believed to be winterkilling.

—Robert E. Young, *Waltham*.

## DEPARTMENT OF POMOLOGY

### A. P. FRENCH IN CHARGE

**The Nature of Winter Hardiness in the Raspberry.** The effects of temperature previous to freezing and the rate of freezing were studied during the year. On November 26, slow freezing to  $-26^{\circ}\text{F}$  caused considerable injury to the buds of the cold-resistant variety Chief and slightly injury to the phloem. Both the buds and phloem tissue of the tender variety Washington were killed. By November 27, there was little injury to the buds or canes of either variety after slow freezing to  $-25^{\circ}\text{F}$ . It is evident that considerable hardening must have taken place during this three-week period. Throughout the rest of the winter, up to March 5, no serious injury could be caused by slow freezing. However, serious injury was caused by rapid freezing even when the temperature went no lower than  $0^{\circ}\text{F}$ . Exposure to temperatures from  $40^{\circ}$  to  $45^{\circ}\text{F}$ . for 2, 4, 6, or 8 days preceding freezing had little effect on the amount of injury, whether the freezing was slow to  $-20^{\circ}\text{F}$ . or rapid to  $0^{\circ}\text{F}$ .

From data obtained from an electrophoretic study of the ground items of cold-resistant and cold-tender varieties of raspberries, pH mobility curves were constructed. If the net charge of the tissue is governed by the protein fraction, the charge will be dependent upon the capacity of the protein molecule to dissociate and to take up protons; hence, proteins of different composition will possess different net charges at the same pH. Since mobility is directly related to net charge, the shape of the curves should be a function of the composition of the protein in question. The curve, therefore, should be of assistance in relating chemical composition to physical properties. Data obtained thus far by the microelectrophoretic method have indicated no significant difference between the two extreme varieties.

On the assumption that cold resistance in plants may be related to gel formation, preliminary tests have been made to determine the



extent of the replaceable hydrogen in the ground tissues. Limited data indicate that the hardier variety is associated with the greater amount of replaceable hydrogen.

—J. S. Bailey, F. W. Southwick, and Emmett Bennett.

**Nutrition of the Highbush Blueberry, Especially in Relation to Soil Reaction.** The work on magnesium deficiency started in Middleboro in 1949, was continued. Leaf analysis indicated that the plants have been able to obtain a supply of magnesium, either from an application of Epsom salts or high magnesium limestone. As a result of the application of Epsom salts to the soil, leaf magnesium appears to have reached a maximum, and there is some evidence that it is decreasing slightly. On the other hand, leaf magnesium of the plants receiving soil application of high magnesium limestone appears to be still on the increase. Varying the amount of magnesium from either source had no effect on leaf nitrogen, calcium, or potassium. It was found that the amount of leaf nitrogen was greater in September than in July.

—J. S. Bailey and Mack Drake.

**Blueberry Culture.** Work during the past year has been largely confined to the testing of new selections. One new U.S.D.A. Selection, 15-121, was added to the collection, and two others, A-91 and GN-87, were discarded because they appeared to have no value under Massachusetts conditions. In cooperation with the U. S. Department of Agriculture, 53 new seedlings in the field of Mr. J. H. Alexander of Middleboro, Massachusetts, were picked out as worthy of further trial. A test was started to compare waste hops with sawdust as a mulch for blueberries.

—J. S. Bailey.

**Improvement of the Wild Lowbush Blueberry.** *Brush Control.* Application of a brush killer composed of 2,4-D and 2,4,5-T, or 2,4,5-T alone in oil in the fall for the control of bayberry was much less effective when the lot was burned the following spring than in an unburned lot. The blueberries on plots that received 3 pounds of borax per square rod have completely recovered two years after treatment. Plots receiving six pounds per square rod still have a few bare spots and plots receiving nine pounds per square rod still have about 20 percent of the area uncovered by blueberries.

Polyborchlorate, applied at the rate of 800 pounds per acre, appears to have eliminated sweet fern and most of the bracken. It damaged the blueberries severely, but there is evidence of their recovering as they did in the borax plots. From 1200 to 1600 pounds appear to have killed almost everything.

Sodium trichloroacetate, up to 100 pounds per acre, dichloral urea up to 120 pounds per acre, and borax up to 1000 pounds per acre appear to have been ineffective against bracken.

*Fertilization.* The first yields from the fertilizer plots indicate that (1) the largest berries were harvested from the plots fertilized the spring of the first fruiting year. (2) plots fertilized the year of the burn

were more weedy, (3) sulfate of ammonia appears not to have stimulated excessive weed growth, (4) 400 pounds of 7-7-7 per acre resulted in as good yield as 800 pounds per acre, and (5) there was little difference in yield between sulfate of ammonia and 7-7-7.

—J. S. Bailey and W. D. Weeks.

**Chemical Control of Weeds in Fruit Plantings.** *Strawberries.* Sodium 2,4-dichlorophenoxy ethyl sulfate was tried at 2, 4, 6, and 8 pounds per acre. Application was made May 4 right after the plants were set. Weed counts made a month later showed that 4 and 6 pounds per acre gave no better control than 2 pounds. It was necessary to go as high as 8 pounds before significantly better control was obtained. At half a pound per acre 2,4-D was no better than the check. Sodium isopropyl xanthate was tried at 6, 8, and 10 pounds per acre. This material was entirely ineffective for weed control. CMU, 3-(*p*-chlorophenyl): 1-dimethylurea, was tried in  $\frac{1}{4}$ ,  $\frac{1}{2}$ , 1, and 2 pounds per acre. At  $\frac{1}{4}$ - and  $\frac{1}{2}$ -pound rates this material gave inadequate control. At the 1- and 2-pound rates it not only killed all the weeds but all the strawberry plants as well. It appears that this material is not selective enough for use in strawberries. Ethyl xanthogen disulfide was tried at  $\frac{1}{2}$  and 2 gallons per acre. This material appeared to be quite effective for the control of broad-leaved weeds, but it caused considerable injury to the strawberry plants, from which they failed to recover. Chloro-IPC appeared to be a very effective weed killer and did not injure the strawberry plants at 2, 3, or 4 pounds per acre; at 5, 6, or 7 pounds per acre, some injury to strawberries was observed.

*Raspberries.* CMU was tried at 1, 2, 4, 6, and 8 pounds per acre. All rates of application caused a chlorosis, which became increasingly severe as the dosage increased until chlorosis was very pronounced at 8 pounds per acre. This material is probably too toxic on raspberries.

*Cultivated Blueberries.* CMU was tried at 2, 4, 6, and 8 pounds per acre on cultivated blueberries, and at none of these rates was there any evidence of injury to the blueberry plants. Even at 8 pounds per acre, it failed to give satisfactory control of quack grass.

—J. S. Bailey.

**Influence of Orchard and Post-Harvest Treatments on the Metabolism of Tree Fruits.** In 1951-52, major emphasis was placed on determining the influence of 2,4,5-trichlorophenoxypropionic acid (2,4,5-TCPPA), which is being considered for pre-harvest drop control, on the rate of respiration, ripening, and surface color development of apples. It was found that when 20 ppm of 2,4,5-TCPPA were applied to apple trees from three to five weeks prior to their usual harvest date, the rate of respiration and ripening of some of the fruits on treated trees was often greatly accelerated. Whenever 2,4,5-TCPPA hastened maturity, the amount of surface red color increased on blushed varieties. In general, the earlier an application of 2,4,5-TCPPA is made, the greater its influence on hastening maturity and color development. However, not all varieties tested were influenced by applications of 20 ppm of 2,4,5-TCPPA as far as maturity and color were concerned. In fact, the response obtained with the same variety varied markedly

from orchard to orchard, which indicates that such factors as nutrition may play a role in determining the extent of response obtained from this hormone.

Experiments with maleic hydrazide absorbed into harvested preclimacteric tomato fruits indicates that this chemical acts as a respiratory inhibitor. However, applications of 250 ppm of maleic hydrazide as a spray to apple trees several days before harvest seemed to have no measurable effect on the rate of respiration or ripening of the fruit at harvesttime or after several months in cold storage. These differences between results with apples and tomatoes may be due to differences in the amount of maleic hydrazide absorbed. It was found, incidentally, while working with tomatoes, that the absorption of one to three milliliters of water through the stem end of preclimacteric fruit may significantly hasten their rate of respiration and ripening.

—F. W. Southwick.

**Influence of Chemical Treatments on Flowering and Fruiting of Fruit Trees.** In 1951, major emphasis was placed upon the testing of naphthaleneacetic acid-type materials, sodium naphthaleneacetate or naphthaleneacetic acid, for thinning apples and peaches after petal fall and comparing NAA materials and 2,4,5-trichlorophenoxypropionic acid (2,4,5-TCPPA) for preharvest drop control of McIntosh apples.

Results from chemical thinning tests conducted in the University and five commercial apple orchards continue to indicate that NAA materials applied from seven days to three weeks after petal fall will satisfactorily thin many apple varieties. It appears that concentrations beyond 30 ppm of NAA materials are not warranted on the varieties grown in Massachusetts. Repeat applications of NAA materials appear to be of no value in thinning. The first application seems to cause the bulk, if not all, of the thinning obtained. Increasing concentration of NAA materials tends to increase the degree of thinning up to a point beyond which little or no additional thinning is accomplished. In general, but not always, the earlier a treatment is made after calyx, the greater the degree of thinning obtained for a given concentration. The reduction in set obtained on a given variety treated at the same time with similar concentrations may often vary from block to block or orchard to orchard. No thinning will occur if the treatment with NAA formulations is made after the June drop is well under way or completed. Apparently, the natural abscission process must still be going on for the material to influence set.

As has been previously noted, chemical thinning tends to reduce total yield but, unless markedly overdone, usually increases the volume of larger-sized fruit. It has been found that after calyx, treatments with NAA materials for thinning will usually (when considerable thinning is accomplished) tend to make many moderately biennial varieties blossom and bear annually. Even such strongly biennial varieties as Baldwin and Early McIntosh may occasionally commence to bear annually after chemical thinning, if heavy thinning is accomplished, the trees are in good vigor, and the growing season is favorable for blossom bud initiation.



Tests were conducted on three peach varieties using naphthaleneacetic acid and naphthaleneacetamide at 15 to 20 ppm approximately five weeks after bloom. Considerable thinning was accomplished with 20 ppm of naphthaleneacetic acid on Golden Jubilee and Early Elberta. No appreciable thinning was obtained on Red Haven at 15 or 20 ppm with either material. Naphthaleneacetamide seems to be less effective for thinning than naphthaleneacetic acid or sodium naphthaleneacetate at a given concentration and apparently must be used at greater dosages to accomplish the same degree of thinning.

Comparative tests between sodium naphthaleneacetate (NaNAA) and 2,4,5-TCPPA on McIntosh apples to determine their effectiveness in reducing preharvest drop were conducted in two commercial orchards. The results indicate that an application of 2,4,5-TCPPA at 20 ppm, approximately two weeks ahead of the natural abscission (August 30), was no better than 20 ppm of NaNAA applied in mid-September for drop control. However, when 2,4,5-TCPPA at 20 ppm was applied approximately one week ahead of natural abscission, or at the start of natural abscission (same time as NaNAA was applied), it was significantly superior to NaNAA. It appears that 2,4,5-TCPPA may control preharvest drop of McIntosh for about three weeks after its application, whereas NAA materials are generally effective for 8 to 10 days, only. However, it appears that 2,4,5-TCPPA requires three to five days after application before it becomes effective in reducing preharvest drop in comparison to NAA materials, which generally require two days after application before drop is influenced.

—*F. W. Southwick and W. D. Weeks.*

**Air Purification in Apple Cold Storages.** During the 1951-52 storage season, home-made activated-carbon, air-purification units were tested in three apple cold storage rooms. These units contained horizontal trays that held the activated coconut-shell carbon. In two of these units the carbon bed was approximately one inch thick in each tray, whereas in the remaining unit the bed was  $2\frac{1}{2}$  inches thick. Carbon was used at the rate of approximately six pounds per 1,000 bushels of fruit. Each unit contained an auxiliary fan or fans to provide a positive air flow through the carbon, and the cleansed air was fed into the main blower-type cooling system.

At each storage where these units were tested there also was an adjacent room without carbon, which served as a check. At the University storage a manufactured cannister-type unit was tested to determine whether it was superior to the home-made units. In each of the carbon and check rooms, composite samples of McIntosh, R. I. Greening, and Cortland were placed, and the effect of air purification on ripening, storage scald, and odor removal observed. These air purifying units reduced box and apple odors effectively but were only temporarily effective in removing musty odors. The storage life was increased from 12 to 17 on McIntosh, 3 to 15 days on R. I. Greening, and approximately 27 days on Cortland by the use of carbon. It appears that home-made units may be as effective as manufactured types in removing odors or prolonging the storage life of apples. In the 1951-52 season, storage scald was not a serious problem and did not appear on the McIntosh by early February. On R. I. Greening and Cortland, which

developed moderate scald, carbon failed to reduce scald, whereas shredded oiled paper did reduce it somewhat. Even when R. I. Greening and Cortland apples were buried in carbon, storage scald developed. It appears that air purification units containing activated coconut-shell carbon are not reliable for scald control. This is particularly true for the variety Cortland when carbon has been definitely inferior to shredded oiled paper over a three-year test period.

—F. W. Southwick and E. Cox.

**Studies of Varieties of Fruits. Apples.** *Mass. C-31* is a (McIntosh x Red Astrachan) seedling, which has fruited for several seasons. It is an attractive, well-colored apple of Early McIntosh season. The quality is good, although it is a bit tart; the flesh of the fruit is crisp and white. *Mass. C-31* produces a well-shaped tree. Its most serious weakness is its biennial bearing habit. However, C-31 should be able to compete favorably with Early McIntosh.

*Jubilee* is a rather recent introduction from Canada. It is an attractive, light red apple of good quality, which appears to have a longer storage season than McIntosh.

*Spartan* is another Canadian introduction similar in size, shape, and quality to McIntosh, but somewhat darker red in color. It may have a longer storage season than McIntosh. Of the two varieties, Jubilee and Spartan, Spartan appears to be the most promising.

**Blueberries.** *Ivanhoe* was named and released by the U.S.D.A. in December, 1951. The berries are large and fairly attractive, although a little dark. Scar and flavor are good, the bush appears vigorous, and it ripened with Concord.

**Peaches.** *Prairie Dawn* trees planted in 1949 bore their first crop in 1951. They had a heavy crop for their age. The fruit is yellow-fleshed, firm, attractive, freestone, and about medium in size; it ripened August 13.

*Early Halehaven* is a sport of Halehaven. It is like Halehaven in all respects except ripening season. In 1951, the fruit matured three or four days after Triogem. The tree is a heavy producer, and considerable thinning will be required to obtain fruit of good size.

*Prairie Daybreak* is an early, yellow-fleshed, freestone peach, which ripens three or four days after Marigold. The fruit is large and attractive but softens rather rapidly. The trees are large, vigorous, and productive.

*Jerseyland* is one of the most promising of the new, early, yellow-fleshed, freestone peaches, which ripens with Marigold or a bit later. The fruit is firm, medium in size, very attractive, and has excellent flavor. It may soften a little too rapidly for shipment to other than near-by markets.

*Starking Delicious* is a good-sized, well-colored, very attractive, yellow-fleshed peach with good flavor. It is almost freestone but rather soft and juicy when ripe. The trees had a fairly heavy crop for young trees. This variety may have possibilities for the home orchard or local trade. The fruit ripened August 12 in 1951.

*Early Flame* is a nectarine with large, attractive fruit. The flavor is good but not quite so good as Garden State. It ripened August 15 in 1951 and would be an excellent nectarine if it did not cling.

*Prairie Sunrise* is a very good, early, yellow-fleshed, freestone peach, ripening just ahead of Red Haven and Oriole. The fruits are firm, attractive, small to medium in size, and have good flavor. It looks promising.

*Wildrose* is an attractive, white-fleshed, freestone peach, which ripens a day or two after Golden Jubilee. The fruit is medium to large in size and attractive, with good flavor. The flesh may be a bit tender for other than local and home use. The trees had a heavy yield for young trees.

*Prairie Schooner* fruits were rather disappointing. Although they are large, yellow-fleshed, and attractive, the flesh was rather coarse, of mediocre flavor, with a tendency to cling. It ripened a day or two ahead of Halehaven.

*Prairie Rose* is a late-midseason peach, which ripened August 28. The fruit is freestone, medium sized, attractive, well colored, and yellow-fleshed. It has fairly good quality, firm flesh, and tough skin. It should ship well.

*Hale Harrison Brilliant* ripened with Elberta September 16, but is better flavored. The fruit is large, attractive, well blushed with red, firm, yellow-fleshed, and freestone. The tree is small and had a medium sized crop for its age.

*Prairie Rambler* is another yellow-fleshed, freestone peach, ripening two to four days after Elberta. The fruits are large and attractive, but the flavor is not too good.

**Strawberries.** *Vermilion* was the most outstanding new introduction tested in 1951. It is a late season berry, large, medium red, attractive, fairly firm, very good quality, and retains its size well. The plant is very vigorous, forms plenty of runners, is resistant to red stele, and satisfactorily productive. Vermilion is well worth testing when a late season berry is desired.

—W. D. Weeks and Staff.

**The Nutrition of Apple Trees.** Chemical analysis of the foliage of 18-year-old McIntosh apples trees revealed that trees receiving annual applications of four and six pounds of ammonium nitrate per tree had more nitrogen, magnesium, and calcium and less potassium and phosphorus than trees receiving two pounds of ammonium nitrate. The foliage of trees receiving 19 pounds of 7-7-7 fertilizer and two pounds of ammonium nitrate had a higher potassium content than the four- and six-pound ammonium nitrate trees. Leaves from trees receiving annual applications of 70, 140, and 210 pounds of hay per tree had the highest potassium and phosphorus content. Leaves from trees receiving three sprays of urea had more potassium and phosphorus than trees that received four and six pounds of ammonium nitrate. Leaf potassium was associated with leaf nitrogen in that potassium decreased as nitrogen increased. Trees with high nitrogen levels appeared to have greater potassium requirements than trees with low nitrogen levels.



The amount of red color development of the fruit was associated with both the nitrogen and potassium content of the leaves. Increases in leaf nitrogen depressed color, whereas increases in leaf potassium increased color. Red color was definitely associated with the nitrogen-potassium nutrition of the tree.

Fruit yield was increased by high rates of inorganic nitrogen, but the yield of Fancy fruit was decreased.

—*W. D. Weeks, F. W. Southwick, Mack Drake, and J. E. Steckel, in cooperation with the Chemistry and Agronomy Departments.*

**Study of Tree Characters of Fruit Varieties.** Vegetative characters of a sweet cherry being grown as Black Tartarian were identical to False Tartarian. This variety was first observed in western New York. The present variety under study was found in Delaware and was reported to have originated in Tennessee. False Tartarian was also observed in Missouri this past summer.

—*W. D. Weeks, A. P. French, and O. C. Roberts.*

**Study of Bud Sports of the McIntosh Apple.** Rogers McIntosh fruit continued to be superior in type and amount of red color. Eighty-seven percent of the crop of Rogers graded U.S. Fancy or better, whereas the crop of the second best sport graded only 67 percent Fancy. The crop from the striped McIntosh graded 38 percent Fancy. All the fruit from Rogers was the blushed type of red. Some of the other sports had both striped and blushed fruit.

Respiration studies and fruit pressure tests indicated that the red sports have slightly slower rates of respiration and firmer fruit than the regular or striped McIntosh. Therefore, Rogers McIntosh may have a somewhat longer storage life than regular McIntosh.

—*W. D. Weeks and F. W. Southwick.*

**The Influence of Various Clonal Stocks on Apple Varieties.** A study of the cross sectional areas of trees propagated on Malling V, I, and XVI showed that V was somewhat more dwarfing than I and that I was intermediate in size between V and XVI. Weak-growing varieties, such as Oldenburg and Wagner, grew very poorly on V and I. On XVI these varieties were no larger than trees of Golden Delicious, McIntosh, and Red Spy on V.

Trees of vigorous varieties, such as Rhode Island Greening and Red Gravenstein on V and I, were much larger than Golden Delicious and Red Spy on V and I. The natural vigor of the variety appears to exert as much influence on tree size as the dwarfing stock used.

Evidence of wooly aphid injury to the roots of some of the Malling stocks was observed during the year. Malling V appeared to be one of the most seriously infected. This infection may help to account for the poor performances of some of our clonal stock trees.

—*W. D. Weeks and F. W. Southwick.*

## DEPARTMENT OF POULTRY HUSBANDRY

FRED P. JEFFREY IN CHARGE

**Inbreeding White Plymouth Rocks for Various Egg Quality Characters.** Fourteen inbred male matings are being carried on each year in White Plymouth Rocks. Some progeny being produced in 1952 are 50 percent inbred. The following egg characters are being studied: (1) egg weight, (2) egg shape, (3) shade of shell color (pink or brown), (4) shell ridging, (5) shell thickness, (6) shell mottling (water absorbed in shell in spots), (7) initial albumen score, (8) albumen score after 21 days' storage in a typical egg room, (9) incidence of blood spots, (10) incidence of colored meat spots, (11) incidence of white meat spots, (12) brown or white spotting on shell, (13) shell finish.

—E. P. Jeffrey and J. R. Smyth, Jr.

**Improving Fertility in Meat-Type White Plymouth Rocks.** Many strains of wide-breasted chickens do not show so high at fertility level as desired. In 1951, Eisenbar males were crossed with a University of Massachusetts strain of dominant white Plymouth Rocks. Of 2143 eggs set, only 1551 or 72 percent were fertile. In the Fall of 1952, 150 pullets from this mating were tested for duration of fertility after a single artificial insemination. Fifty of these pullets showed a duration of 10 or more days and were retained as breeders. Thirty-five cockerels from the 1951 mating were also tested for duration of fertility as measured in at least five females selected at random. Four of the best type males whose mates showed a duration of 10 or more days were retained and mated with the 50 selected females. From this mating, 1628 eggs were set over a four-month period, and 1547 of them or 95 percent proved to be fertile. These results indicate that pre-testing males and females for duration of fertility is to be recommended when a fertility problem exists.

—F. P. Jeffrey.

**Broodiness Has Been Completely Eliminated in Three Generations of R. I. Reds.** Three generations of birds have appeared that show no evidence of the broody instinct as was pointed out in *Research in Review* (Vol. 1, No. 1, 1952). This line is now being improved for fecundity because their egg production is rather mediocre. Theoretically, the birds in this line should transmit no genes for broodiness in offspring from crosses with other strains and breeds. Efforts are now directed to discover how fecundity is affected and to test the value of the stock for crossing.

—F. A. Hays.

**Genetics Plays a Part in Regulating Fertility in Chickens.** Substantial evidence is available to indicate that sex-linked genes for high and low fertility are transmitted from father to daughter and that selection of mothers for high fertility has no effect on the character of daughters produced.

Old males are often sexually inactive in the cold winter period of short days. Artificial light has considerable merit in activating such males, and exposure to three foot-candles of light for three to four hours in the early morning is about as effective as all-night exposure.

—F. A. Hays.

**Selection Effectively Improves Hatchability.** Through selection for high hatchability a line has been developed that consistently hatches a high percentage of fertile eggs. In contrast, a line that consistently hatches fewer than 50 percent of fertile eggs has been developed through selection. Particular attention is being directed towards discovering the specific gene effects that induce low hatchability, and a search for lethals is being made.

—F. A. Hays.

**Breeding for High Fecundity Gives Much Valuable Information.** The sex-linked gene for early sexual maturity does not appear to be closely linked with the sex-linked gene for rapid chick feathering.

Pullet breeders are more efficient than yearling breeders in hatchability and in the number of chicks produced in a definite period, but chicks from yearlings are larger and in many cases superior in viability.

The onset of sexual maturity in pullets definitely retards the rate of growth but has no very significant effect on mature body weight. Age at sexual maturity does not affect subsequent mortality. Age at sexual maturity has a very significant effect on first-year egg production. Very early sexual maturity is definitely associated with rapid chick growth to twelve weeks of age so that flocks should be bred to begin laying at about five months.

The sex-linked gene for rapid chick feathering has no effect on chick growth to 12 weeks of age, but the autosomal gene for rapid back feathering is positively associated with rapid early growth.

Winter intensity shows a heritability of about 16.28 percent in our Rhode Island Reds.

A rather extensive study indicates that the daughters of brothers laid a significantly greater number of eggs than the daughters of their full sisters, suggesting unknown sex-linked genes in operation.

Older sires and dams gave a reduced mortality in chicks to the age of eight weeks, and the dams had a greater influence than the sires on viability of chicks. Abnormally high sex ratios in chicks often occur when older parents are used.

Breeding flocks for very early sexual maturity—about five months of age is to be recommended as an economical procedure because such birds lay more eggs the first year and because the chicks grow more rapidly to the broiler age.

Many other phases, such as inbreeding, strain crossing, and breed crossing, in relation to fecundity and viability are being investigated. The problems of over-dominance and epistosis are being studied in the flock.

—F. A. Hays.

**The Duration of Fertility in Turkeys.** The duration of fertility after artificial insemination for 48 Jersey Buff turkey hens was studied. The average duration of fertility for this population was 47.5 days. The



coefficient of variability for this population was 14.7 percent, which is about one-half that found in White Plymouth Rock chickens studied. The "stale sperm" effect is extremely marked in the turkey, but hatchability was not affected for five weeks after an insemination. The average fertility for the population was greater than 90 percent for 30 days after artificial insemination. These data indicate that a breeder could use an interval as great as four weeks between inseminations.

—J. Robert Smyth, Jr.

**Mating Frequency in the Turkey.** All matings in which each of 40 Jersey Buff turkey hens in four breeding pens participated were recorded. The possible mating period was limited to the late afternoon for six days a week during March, April, and May. During this period the number of matings per hen varied from none to 28. The average fertility for the hens mating from one to six times was 82.9 percent, whereas those hens that mated twelve or more times laid eggs that were 96.6 percent fertile. Although turkey hens definitely mate more after a broody period, it was found that the desirable combination of high mating frequency and nonbroodiness does occur.

—J. Robert Smyth, Jr.

**Selection for Duration of Fertility in the Domestic Fowl.** All surviving female offspring resulting from the second generation of selection for duration of fertility after artificial insemination were tested. The average duration for the line selected for increased sperm survival time in the female reproductive tract was 11.0 days. The low duration line females averaged 8.2 days. Although this demonstrates some progress by selection, the genetic gains have not been large. This indicates that the heritability of the capacity of the female to affect the duration of the life of sperm *in vivo* is low. At the present stage of selection no individuals that have shown a more extreme duration of fertility than was observed in the original nonselected population have been produced. Although the female offspring as a whole show a decline in their duration of fertility during the late spring, some superior individuals were observed, which were able to overcome this depressing effect of season.

—J. Robert Smyth, Jr.

**The Genetics and Physiology of the Length of Incubation Period in the Chicken.** Additional progress was made in the second generation of selection to separate two lines of chickens differing in the length of their incubation period. The difference between the means of the early and late hatching lines was increased over the previous generation's difference by five hours. The average hatching time for the early line was 20 days and 22.9 hours after the start of incubation, and the average for the late line was 21 days and 11.4 hours. This increase in the difference between the two lines was due largely to an increase in the time required for the late line to hatch. The difference in egg size between the lines was decreased by 40 percent during the same generation of selection. This indicates that physiological factors are involved, which are independent of the physical size of the egg.

—J. Robert Smyth, Jr.

## DEPARTMENT OF SEED CONTROL

FREDERICK A. McLAUGHLIN IN CHARGE

Enforcement of the Seed Law, together with the desire of seedsmen to comply with requirements of this Act, and a growing interest of the public in good seed, have resulted in a large number of service samples being sent to the Seed Laboratory for testing. From July 1, 1951, to June 30, 1952, 6091 service and inspection samples of seed were received and worked at the laboratory. The laboratory also received and cleaned 61 lots of tobacco seed.

Analysis of inspection samples indicates that most seedsmen have complied with label requirements of the Seed Law. A large part of the violations found are technical in nature rather than flagrant.

Operation of the Seed Law is reported in an annual control series bulletin issued for that purpose.

## DEPARTMENT OF SHADE TREE LABORATORIES

MALCOLM A. McKENZIE IN CHARGE

**General Program.** The greatest increase in the work of the Laboratories has been in requests for information on municipal tree planting and maintenance programs with special reference to tree surveys and uniform pest control. Some communities have organized tree committees to make sure that existing trees are cared for properly and new housing developments are furnished with appropriate plant materials. Wind-, rain-, snow-, and ice-storm damage were found to be less severe during the past year than in 1951, and tree foliage in general was more lush in the Spring of 1952 in association with frequent spring showers. Forty-eight diseases of 31 species of trees were identified from 8416 specimens received or examinations in the field, including principally the Dutch elm disease and other disease of elm. At present, the most urgent needs of the program are investigations of the oak wilt problem and also the study of new pesticide materials.

**Dutch Elm Disease Control Testing.** From June 1, 1951, to June 1, 1952, the Dutch elm disease was found in samples from 39 additional towns, making a cumulative total of 249 towns involved since the disease was first known here (1941, Alford, Berkshire County). Summarily, in laboratory studies by means of tissue plantings in artificial culture media, the disease fungus, *Ceratostomella ulmi* (Schwarz) Buisman, has been isolated from 13,107 trees (June 1951-52, 4180 trees) in 11 of the 12 counties on the mainland, Barnstable, Dukes, and Nantucket being reported as disease-free at present.

—*M. A. Mc Kenzie, D. H. Marsden, R. L. Coffin, M. M. Munson, H. S. Clark, J. Maspero, J. G. Moline, and M. M. Hart.*

**Oak Wilt.** Widespread publicity has been given to the oak wilt problem by the Federal Government and a National Committee. As a result, numerous inquiries about the disease have been received, and a circular has been prepared to furnish particular instructions for sending

samples from suspected oaks in order that necessary laboratory tests may be completed. The disease is prevalent in the South and Midwest, but it is not known to occur in Massachusetts or elsewhere in New England.

—M. A. Mc Kenzie.

**Tree Damage in Construction Work.** Tree sites are commonly altered without much attention to serious effects on trees already established. Investigations have shown extensive mutilation of root systems by such severe measures as cutting off large portions of roots. Also, a variety of additional injuries have been observed associated with progressive deterioration often revealed by chronic foliage deficiencies, or otherwise. In current increased construction of housing developments, airports, parking areas, and other construction, the fundamental needs of trees retained in sites involved should be evaluated carefully. Foresight of adequate provision in original construction plans is the most economical treatment. Hindsight of remedial measures permits salvage of trees in some cases. Proper drainage is aided by the use of dry wells and loose stone, and air circulation is increased by vertical tiles.

—M. A. Mc Kenzie.

**Pruning Elms Affected with Dutch Elm Disease.** This experiment, started in 1950, was continued during the Summer of 1951. To date, 15 out of 24 elms with restricted infections of *Ceratostomella ulmi* have apparently been freed of disease by prompt removal of the affected parts. Early detection of disease symptoms and quick action in removing affected branches continue to be most essential, if diseased trees are to be saved.

—D. H. Marsden.

**Effect of Dutch Elm Disease on the Elm Population of a Town.** Critical analyses of the annual incidence of Dutch elm disease in certain towns in Massachusetts have been undertaken to obtain statistical data on the efficacy of recommended control programs with special reference to sanitation. One such analysis for the Town of Amherst has revealed the following significant facts: In four years (1948 to 1951) a total of 245 elms are known to have been affected with the disease. Of this total, 125 were wild elms, 37 were privately owned shade trees, and 83 were roadside elms. The 83 roadside trees constitute approximately 4.6 percent of the roadside elm population. The relative annual incidence of disease has been 1.0, 3.3, 9.0, and 4.3. A progressively intensified program of sanitation has been carried on in Amherst since the disease was discovered there in 1948. Although a few more years probably must elapse before a final evaluation of the control program may be made, the data now available would seem to indicate that the Dutch elm disease has not been out of hand in that town. Also of interest, and perhaps of significance in predicting the magnitude of the Dutch elm disease problem with which a town may be faced, are data on the classification by size of diseased roadside elms in Amherst. It was found that 3.2 percent of the roadside elms from 2 to 10 inches d.b.h. (diameter breast high) have been affected, 1.9



percent of those from 11 to 20 inches; 24.4 percent, from 21 to 30 inches; and 66.6 percent, over 30 inches in diameter.

— D. H. Marsden.

**Studies in Wood Decay.** Laboratory examinations of creosoted timbers that had decayed prematurely in service revealed that inadequate initial retention of preservative, exposure of the inner unimpregnated wood through seasoning cracks and mechanical injuries, erratic penetration of the preservative, and a reduction in the amount and unit effectiveness of the preservative through weathering or other action are all factors that may singly or in combination predispose creosoted timbers to early decay. Although the wood-rotting Basidiomycetes actually break down the wood elements, and thus are the decay organisms, it was found that molds, such as *Hormodendrum resinae*, *Trichoderma viride*, *Paecilomyces varioti*, and *Penicillium* spp., and bacteria are also invariably associated with decayed, creosoted timbers. It may be conjectured that these molds and bacteria play a significant role in the ecology of decay of preservative-treated wood.

— D. H. Marsden.

**Control of Certain Leaf Miners and Mites.** The larvae of the solitary oak leaf miner, *Cameraria hamadryadella* (Clemens), were all killed in their mines by sprays of one pound of 25 percent wettable lindane, two pounds of EPN 300 and 2 pounds of 15 percent wettable parathion per 100 gallons of water. One pint 40 percent nicotine sulfate plus four pounds soap, two and one-half pounds 40 percent wettable chlordane, and two and one-half pounds 40 percent wettable toxaphene powder, though exhibiting some killing power on larvae in the mines, were less effective than the first three materials.

A leaf miner in inkberry, *Ilex glabra*, was identified as *Phytomyza aquifolii* Gour. by the U.S.D.A., Division of Insect Identification. It is a species closely related to but distinct from the holly leaf miner, *Phytomyza ilicis* Curtis.

Sprays of Aldrin, dieldrin, toxaphene, chlordane, lindane, EPN 300, parathion, metacide, and schraden applied with a small knapsack sprayer failed to control first generation larvae of the inkberry leaf miner. Miners of the second generation were almost completely eliminated by sprays of two pounds of 25 percent aldrin or dieldrin in 100 gallons when applied with a hydraulic sprayer at 400 p.s.i. One pound of 25 percent lindane and two pounds of 12 percent gamma BHC were less effective but reduced the infestation to about one-half that in the unsprayed check plots.

Parasitism of the first generation inkberry leaf miner larvae was common. Four species of parasites were reared from leaves collected in a local nursery, one of which represented a new genus and species.

Both water miscible and wettable powders of Aramite controlled boxwood mite for two or more weeks. So-called stabilized formulations were not effective from a greater length of time than regular formulations. Water miscible formulations were somewhat longer lasting than wettable powders.

Water miscible Aramite formulations diluted 1-800 did not have any adverse effect on the bloom of blue spruce.

— W. E. Tomlinson and P. L. Rusden.

## DEPARTMENT OF VETERINARY SCIENCE

K. L. BULLIS IN CHARGE

### Poultry Disease Control Service.

1. *Pullorum Disease Eradication.* During the 1951-52 testing season 1,343,955 chickens in 417 flocks were tested. Only 0.016 percent of the tested chickens were classified as reactors. Five flocks were classified as positive at the close of the season. Of the total birds tested, 98.52 percent were in nonreacting flocks. No infection was detected among 35,642 tested fowl other than chickens. The testing results will be reported in more detail in the Thirty-second Annual Report of Pullorum Disease Eradication in Massachusetts.

2. *Poultry Disease Diagnostic Service.* During the past year, diagnostic service in poultry diseases was available at two laboratories; namely, the branch laboratory at the Waltham Field Station, Waltham, and at Amherst. The volume of service rendered greatly exceeded the service given in any previous year. The following is a report for each laboratory for the 1951 calendar year.

AMHERST. During the calendar year, 3,971 specimens in 851 consignments were examined. Of these, 738 were delivered in person. The specimens were classified as follows: 3,449 chickens, 394 turkeys, 26 porcine, 25 bovine, 19 chinchillas, 10 rabbits, 8 mink, 6 each of canine and pheasants, 5 ducks, 4 each of blue birds and ovine, 3 canaries, 2 each of caprine, geese, and pigeons, 1 each of equine, muskrat, quail, racoon, squirrel and ruffed grouse. Respiratory diseases, discussed in a separate section, constituted the majority of diagnoses in chickens (469). Fowl paralysis (64), various tumors (64), coccidiosis (62), and epidemic tremor (17) were diagnosed frequently. Diseases diagnosed most frequently in turkeys were erysipelas (9), infectious sinusitis (5), enterohepatitis (4), and Newcastle disease (4).

*Brucella melitensis* was identified in aborted pig fetuses from one herd in the State. This appears to be the first time this species of *brucella* has been identified in this region. Although the origin of this infection could not be determined, it appeared likely that it was transmitted from slaughterhouse offal.

*Listeriosis* was identified in one goat examined. The disease is not uncommon in this country, but this case is thought to represent the first identification of the infection in mammals in the State.

WALTHAM. During the calendar year 1951, 8,309 specimens were submitted in 1,553 consignments to the branch laboratory for examination. The specimens were classified as follows: 7,265 chickens, 978 turkeys, 22 pheasants, 13 ducks, 7 pigeons, 6 geese, 5 canaries, 5 mink, 4 swine, 2 peafowl, and 1 each of catbird and robin. The hemagglutination-inhibition test was performed on 3,246 individual serum samples.

The ten most prevalent chicken diseases identified were Newcastle disease (242), infectious bronchitis (163), coccidiosis (136), lymphocytoma (130), capillariasis (123), fowl paralysis (116), respiratory infection (82), fowl typhoid (40), infectious laryngotracheitis (40), and ascariasis (39).

The five most prevalent turkey diseases identified were coccidiosis (27), enterohepatitis (16), erysipelas (16), turkey pox (13), and omphalitis (8).

Renal coccidiosis in geese and sarcosporidiosis in wild ducks were each identified once for the first time at the branch laboratory.

3. *Poultry Bronchitis Control.* During the 1951 calendar year, 1,096 flocks were enrolled in the infectious bronchitis immunization program. In general, the results were very satisfactory, and the incidence of infectious bronchitis outbreaks among laying flocks has declined greatly. Investigations are in progress to improve the vaccine and method of inoculation employed in the control program. Among 142 flocks tested for their immunity to infectious bronchitis, 104 were immune, 19 nonimmune, 11 questionable, and 8 immune and non-immune. Among 290 flocks tested for their immunity to Newcastle disease, 92 were immune, 150 nonimmune, 9 questionable, and 39 immune and nonimmune.

4. *Chronic Respiratory Disease.* During the calendar year 1951, virus isolations from field cases yielded the following results: chronic respiratory disease (CRD) agent (74), infectious bronchitis (3), infectious sinusitis (3), infectious laryngotracheitis (4), and in 10 cases no virus was isolated.

CRD, a serious threat to the poultry industry, was investigated during 1951. The disease is widespread, and its incidence is increasing in Massachusetts. Recent findings reveal that the causative agent may be present in embryos and day-old chicks that have their origin in flocks affected with CRD. Various properties of the agent have been investigated, and it has been discovered that the agent can be propagated in serum-broth medium, that it is visible in stained smears when examined with a light microscope, and that it is sensitive to some of the antibiotics. The use of antibiotics may prove to be of some value in the control of the disease.

—H. Van Roekel, G. H. Snoeyenbos, G. P. Faddoul, Jack E. Gray, M. K. Clarke, O. M. Olesiuk, Joseph E. Gray, C. D. Brandt, G. W. Fellows, H. A. Peck, and R. A. Bennett.

**Newcastle Disease Immunization Studies.** Flock vaccination against Newcastle disease by spraying the B<sub>1</sub> strain (intranasal type) of virus was investigated in field tests during the past year. This method of application has been employed for revaccination of broiler flocks after day-old vaccination, revaccination of replacement flocks, initial vaccination of young stock three weeks of age or older, and initial vaccination of replacement flocks prior to coming into egg production. The vaccine was administered with a DeVilbiss nasal atomizer No. 251 at the rate of 20 ml. per 1000 birds. In flocks where a vaccine of high virus concentration (embryo titer of  $10^{-7}$  or greater) was administered, the antigenic response was uniformly good. When vaccines of low virus concentration were applied, the flock immunity was very irregular. Reaction noted after vaccination was mild to marked respiratory symptoms accompanied by a slight drop in feed consumption. Mortality was zero or negligible with the exception of a few flocks in which there appeared to be complications with other infections.



A study of the hemagglutination-inhibition (HI) and serum-neutralization (SN) titers in some of these flocks showed that the HI test was a good means of determining the flock response to vaccination, but was not always a good measure of flock protection several weeks after vaccination. The SN test was a better measure of the duration of immunity. In flocks that showed a good response after vaccination, high levels of serum antibodies have been demonstrated as long as 12 months after vaccination.

—*S. B. Hitchner and G. Reising.*

**Mastitis Testing Laboratory.** During the calendar year of 1951 a total of 35,572 milk samples was tested. Of this number 18,515, were from 20 State institution herds, 1,070 from the University Farm Department herd, and 15,987 from 148 private herds. Included in the latter were 368 samples from two county agricultural school herds, 26 from five goat herds, and 4,057 from eleven demonstration herds. In addition to the total number of samples tested, 60 were received in a condition unsuitable for testing.

—*W. K. Harris and I. M. Reynolds.*

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